Report and Recommendations
NORTHEAST MULTISTATE ACTIVITIES COMMITTEE MEETING
March 15, 2024
4:00 PM ET Zoom Teleconference

Members present: Puneet Srivastava (Maryland-Chair), Jason White (CT-New Haven), Blair Siegfried (Penn State), Chris Smart (NY Geneva), Cindy Fitch (WVU/NEED), [Non-voting, ex officio: Rick Rhodes (NERA), David Leibovitz (NERA)]

Ready check of Proposal Draft

- NE_TEMP1: *Northeast Regional Center for Rural Development*, 10/2024 – 09/2029 [MAC review of Budget Justification submitted by Stephan Goetz] (pg 4)
    - Blair posed questions on the budget justification regarding salary/fringe previously covered by the college and increased travel support.
    - NERCRD has made positive contributions and is widely recognized in the Northeast for its activities. Blair supports sending the proposal out for scientific peer review.
    - **The MAC unanimously approved the ready check for the NE_TEMP1 proposal and it will move forward into peer review.**

Review of NRSP Review Committee Materials for Regional Spring Meetings

- NRSP_temp3: The National Atmospheric Deposition Program (NADP) proposal, reviews, response to review, and budget [Renewal of NRSP3, Northeast AA: Jason White – CT New Haven] (pg 14)
    - Long, successful project NRSP. The team has been active since 1992. Peer reviewers responded positively about the proposal and called for some minor revisions.
    - NRSP guidelines are written to recommend budget models that demonstrate declining off-the-top funding support year to year. The guidelines also designate NRSPs in two categories: "Capacity/core" and "New/emerging initiatives". NRSP3 is considered by agInnovation to be Capacity/core.
    - Jason recommended sending the proposal back to the team for revisions in response to the peers reviews prior to approval.
    - **The MAC supports Jason's recommendation to send the proposal back to the NRSP3 team for revisions prior to approval. The recommendation was approved unanimously by the MAC and will be presented to NERA prior to being sent to the NRSP Review Committee.**

Request to Approve Peer Reviewed Multistate Activities (MAC recommends to NERA)

- NE_TEMP2439: *Improving the health span of aging adults through diet and physical activity*, 10/2024 – 09/2029 [Renewal of NE1939, AA: Ingrid Lofgren – Rhode Island] (pg 114)

- Ingrid Lofgren is a senior faculty member at the University of Rhode Island and has been designated by URI to serve as the AA for this project.
- This project was initiated in 1989 at the University of the District of Columbia, one of the oldest projects in the northeast portfolio to be anchored at UDC, the only urban Land-grant campus in the region.
- The project team works to ensure optimal health of aging adults through nutrition and physical activity.
- Participation is broad across regions and extends beyond the LGU system.
- **The MAC unanimously recommended approval of the NE_TEMP2439 proposal. This will be presented to NERA for full approval at the Spring meeting.**

MAC Discussion Items

- NE nomination for the 2024 agInnovation Award for Excellence in Multistate Research (pg 155)
  - The Northeast has not won this award since 2010. All Northeast Administrative Advisers are encouraged to submit a nomination and carefully adhere to the instructions in the Call for Nominations.
  - **NE2210 (Forage crops, AA Eric Bishop von Wettberg-UVM) is interested in submitting a nomination.**
  - **NE2334 (Avian diseases, AA Bob Taylor-WVU) and NE1939 (Nutrition, AA Ingrid Lofgren-URI) may be strong candidates for this award. Rick will approach these AAs seeking their interest in drafting a nomination.**
  - Strong participation and leveraged funding amounts are the two main attributes of projects with successful nominations in recent years. It may be worthwhile to have institutional communicators review the nominations before they are submitted.
- NE multistate activity nomination for 2024 Multistate Research Fund Impacts writing workshop
  - Sara Delheimer is seeking a nomination from each region. Typically, NERA selects projects in year 1 or year 5 of their cycle.
  - **The MAC supports recommending three potential projects for the impact writing workshop: NE9 (Conservation and Utilization of Plant Genetic Resources), NE2334 (Avian Diseases), NE2335 (Controlled Environment Agriculture). Rick will submit these nominations to Sara Delheimer for consideration.**

Administrative Adviser Assignments

- NRSP 11: Building Collaborative Research Networks to Advance the Science of Soil Fertility: Fertilizer Recommendation Support Tool (FRST), 10/2023 – 09/2028 [New project, Nathan Slaton, University of Arkansas, Lead AA]
  - NRSPs have AAs from all regions; currently seeking a Northeast AA
  - **Jason White volunteered to serve as the Northeast AA for NRSP11. The MAC unanimously supports recommending this to NERA.**
- Calvin Keeler (retired from University of Delaware)
  - NE2202: *The Equine Microbiome*

- **Adele Turzillo (Penn State) will be approached to serve as the AA for NE2202.**

Informational Items

- NERA activities up for Mid-term review in FFY2024
  - NE2140: Sustainable Management of Nematodes in Plant and Soil Health Systems (AA: Anton Bekkerman – New Hampshire)
  - NE2101: Eastern White Pine Health and Responses to Environmental Changes (AA: George Criner – Maine)
  - NECC2103: High tunnel specialty crop production (AA: Anton Bekkerman – New Hampshire)
  - NEERA2104: Northeast Region Technical Committee on Integrated Pest Management (AA: Margaret Smith – Cornell)
- NERA activities ending 09/30/2024
  - NE1939: Improving the health span of aging adults through diet and physical activity (**revised in response to peer review, awaiting NERA approval**)
  - NE1942: Enhancing Poultry Production Systems through Emerging Technologies and Husbandry Practices (**under peer review**)
  - NE1943: Biology, Ecology & Management of Emerging Disease Vectors (**under peer review**
  - NE1941: Environmental Impacts of Equine Operations (**elected to not renew**)
  - NECC1901: Integrating Genomics and Breeding for Improved Aquaculture Production of Molluscan Shellfish (**interest in renewal TBD**)
  - NE1938: Carbon Dynamics and Hydromorphology in Depressional Wetland Systems (**interest in renewal TBD**)

NE_TEMP1: Northeast Regional Center for Rural Development

Status: Draft

Duration 10/01/2024 to 09/30/2029
Admin Advisors:
NIFA Reps:

Non-Technical Summary

Rural areas in the Northeast and nationally continue to struggle with recovery from Covid-19, which has compounded the long-term adverse impacts of globalization, technological change, job losses and population outmigration. Addressing these impacts is essential to ensure the sustainable growth of rural areas, which in turn are vital to the nation's food supply and the stewardship of its natural resources. The Northeast Regional Center for Rural Development conducts original research with its partners and connects faculty and Extension educators in the region with one another and to national collaborators and resources, thereby creating synergies and reducing duplication of effort. Our five project goals are approved by the Center's Board of Directors' and are to: support rural economic development, innovation, and entrepreneurship; facilitate tourism development, including agritourism; address climate change and carbon levels; measure and promote food and nutrition security; and build regional capacity and facilitate the integration of research and outreach. The target audiences for our work range from farmers and other private businessowners to elected officials at the federal, state, and local levels. These individuals may benefit from this project by receiving research-based information to help guide the recurring decisions they have to make to remain profitable or to ensure sound and efficient uses of public expenditures. The activities proposed here will generate collaborative research findings, and through widespread dissemination of the results through presentations, working groups, factsheets, and other tools, we expect to reach all decisionmakers who may benefit from the project outputs.

Statement of Issues and Justification

The US Northeast's agricultural and rural areas face challenges ranging from land use conflict to climate change, environmental concerns and lagging economic development, accentuated recently by the lingering effects of the Covid-19 pandemic. These regions also have significant opportunities to contribute to the nation's prosperity and food supply, sustainability of the environment, and societal equity and justice (Mitchell et al., 2023), but more research is needed to identify specific, place-based feasible and sustainable strategies to realize these opportunities.

The Northeast Regional Center for Rural Development provides research-based information that helps create regional prosperity through entrepreneurial and cluster-based innovation, while assuring balanced uses of natural resources in livable communities in the northeastern United States. We carry out our mission by conducting original research with collaborators, pursuing strategic partnerships with public and private entities, and linking our stakeholders to opportunities and resources; we also compile and disseminate research-based outreach materials through a variety of formats. We serve as a hub that connects researchers and Extension educators across state borders and topic areas. Our work is motivated by the continuing challenges rural areas face both in the region as well as nationally. In essence, supporting NERCRD is an investment in the resilience and prosperity of the Northeast's rural populations, contributing to sustainable economic growth and improved quality of life for residents.

The need for the research proposed here has been indicated by stakeholders ranging from the leadership of the land grant universities in the Northeast to individual campus-based faculty and county-based educators, as well as by government and nonprofit or private sector partners. Specific sources of input include: the Center's Technical Advisory Committee, which advises the Board of Directors; the results of comprehensive listening sessions on rural economic recovery from Covid-19 conducted by the four Regional Rural Development Centers on behalf of USDA-NIFA (Entsminger et al., 2023); the Northeast Agenda – A Joint Vision for the Future of the Northeast (Mitchell et al., 2023) prepared by the Northeastern Regional Association of State Agricultural Experiment Stations (NERA) and the Northeast Extension Directors (NEED); and other stakeholders including national program leaders at NIFA, the Economic Research and Forest Services, USDA Rural Development, and the NSF's National Center for Science and Engineering Statistics.

Importance of the work: Providing research-based information to address the problems facing the Northeast is critical if taxpayer funds are to be put to their most cost-effective uses in addressing societal problems. If the work is not carried out communities and individuals will not have the opportunity to develop a complete and research-based understanding of the factors that support or impede growth of minority and female entrepreneurship, or the factors that support or impede tourism and agritourism development with sustainable beneficial impacts for the local communities where they are based; the factors that support decarbonization, innovation and the transition to renewable energy along with their impacts for different kinds of rural communities; historical crop production patterns and their shifts over time in order to predict future production prospects including implications for the spatial distribution of nutrient dense foods, with implications for population health.

Technical feasibility: as documented in the section below on Related, Current and Previous Work, the Northeast Regional Center for Rural Development has a proven track record of successfully completing the kinds of projects proposed here. As such, the feasibility of achieving the objectives is not in question.

Given the region-covering nature of the issues addressed, and limited faculty and educator resources at individual experiment stations in the region, taking a regional approach in a multi-state effort that draws on the expertise of collaborators in the different states represents a critical advantage.

Expected impacts of successful completion of this work include more-informed decision makers at all levels of government as well as individuals, farmers and businessowners throughout the region in different industries who make economic decisions about sustainable and profitable resource allocations every day. In turn, we expect to see more resilient, vibrant, and sustainable businesses, farms, and local economies over time, with more strategic federal and private investments that benefit from higher economic and social returns, including healthier populations and more equitable socioeconomic outcomes across different ethnic groups and across gender.

Related, Current and Previous Work

The Northeast Regional Center has a long history of contributing to the research and outreach needed to address the region's current and emerging challenges. Selected highlights of the work undertaken by the Center include:

NERCRD staff use state-of-the-art research tools: We published the first application of artificial intelligence in the form of natural language processing to big data (Tweets) to predict where food supply chains were breaking down during Covid-19 (Goetz et al., 2023). This interdisciplinary research included faculty from the College of Information Sciences and Technology, and collaborators as far away as Doha, Qatar. Helping to train or support the next generation of scientists, the study also included two Ph.D. students, one postdoc and two junior faculty members.

The Center's research (Tian et al., 2022) on the role of food pantries in reducing food insecurity early in the pandemic won an Outstanding Article Award from the *Journal of Agricultural and Resource Economics* and the 2023 High-Impact Research Publication in Nutritional and Food Security Award from the College of Agricultural Sciences at Penn State University.

NERCRD research has been used at the highest levels of the federal government: The 2019 Economic Report of the President, prepared by the Council of Economic Advisors (CEA), cited three scientific papers written by NERCRD staff and collaborating researchers (Goetz et al., 2018; Rupasingha and Goetz, 2013; and Goetz and Rupasingha, 2009); the older citations underscore the durability of the Center's work. In an email, CEA Chairman K. Hassett wrote: "We found your research to be insightful and critical to the completion of the 2019 Economic Report of the President."

NERCRD's data resources have been used or cited in a variety of socioeconomic academic subdisciplines: The social capital data collection is recognized as the gold standard for measuring county-level social capital in numerous academic fields, with over 1,000 citations (Google Scholar). For example, it was used by economists at Harvard University and UC Berkeley in their groundbreaking study on rural and urban economic mobility (Chetty et al., 2014).

NERCRD's own research on intergenerational mobility has also been impactful. A News story about a NERCRD study of human capital and intergenerational mobility (Swayne, 2018) received more than 3,400 comments on Reddit, and more than 57,000 "upvotes," signaling that the topic resonated with these users.

The Center has been instrumental in supporting the national recreation economy, a critical new engine of rural economic growth. Starting with its support of the National Extension Tourism Network (see, e.g., Extension Foundation, 2022), the Center assisted West Virginia University, Vermont, New Hampshire and Penn State faculty in securing an AFRI competitive grant, and also secured New Technologies in Agricultural Extension funding. This was followed by the establishment of a new regional Hatch project (NE2251, Tourism Resilience and Community Sustainability: Adaptation and Recovery of Rural Businesses and Destinations). Most recently, the Regional Rural Development Centers were charged by NIFA to help implement a Memorandum of Understanding between NIFA, the Forest Service and Rural Development (USDA, 2022).

In addition to training graduate students and postdoctoral students, the Center was instrumental in helping a total of seven faculty members secure six major NIFA grants, to the best of our knowledge, for the first time. The Center's earlier $5mn local food systems grant connected extension educators at Penn State, Cornell and West Virginia State University and other land grants with faculty at Columbia, John Hopkins, and Tufts universities, among others.

As noted above, this proposal draws on a large body of ongoing, related and previous work that is guided by the Center's Technical Advisory Committee and approved annually by a Board of Directors (land grant university administrators), and a large-scale listening session effort that the Center conducted in 2022 along with its three counterpart institutions in the North Central, Southern and Western regions on behalf of NIFA (Entsminger et al., 2023). This proposal also aligns closely with the three Key Priorities set forth in the Northeast Agenda document (Mitchell et al., 2023), as well as USDA-NIFA goals. The Center's Board-approved broad priority areas currently are: 1. Economic development, resilience, and innovation; 2. Food systems, nutrition security, and agriculture; and 3. Capacity building and facilitation. Within these three broad priority areas, the five specific objectives listed in the next section are proposed over the next 5 years.

Objectives

1. Support rural economic development and entrepreneurship, and innovation. We will conduct research and outreach on the success factors, barriers and opportunities for female and minority entrepreneurs in the region, including the roles of access to credit, broadband and market information, as well as child and elder caregiving. We will also examine the barriers facing female and ethnic minority farmers using National Agricultural Statistics Service and related public data sets and seek to evaluate the role of policy levers such as the Community Reinvestment Act in facilitating access to credit among other resources.
2. Facilitate tourism development, including agritourism. We will help to implement the new Memorandum of Understanding signed by NIFA, Rural Development and the U.S. Forest Service, with the goal of helping rural communities take better advantage of their natural resources, while managing them in a sustainable manner. In Northeast states without large forest stands, we will conduct research to help communities understand their tourism possibilities. We will conduct research on the role of clusters and other explanatory factors in supporting tourism expansion and resilience and develop research-based outreach materials to assist farmers seeking to expand their agritourism activities, taking advantage of synergies and proximity to urban consumers. The importance of infrastructure development, including broadband availability and physical accessibility as measured in the Economic Research Service's new ruggedness index, will also be assessed.
3. Address climate change and carbon levels. We will examine the state of greenhouse gas emissions in the Northeast region and contributors to energy intensity, and determine opportunities for decarbonization, including the use of wind turbines (on shore, offshore) and solar panels, combined with agri-voltaics. These opportunities will include assessing regional supply chains for producing green energy, including barriers to their development, such as workforce availability. The more expansive use of land under green energy production has the potential to profoundly impact rural communities, and landowners; suitably targeted research can help to develop guidelines for mitigating adverse impacts.
4. Measure and promote food and nutrition security. We propose to build on the Center's long history of work on local and regional foods systems by documenting the contribution of the region's food system to the nation's nutrient supply (lacking the masses of land needed to grow bulk commodities, the region nevertheless contributes disproportionately to the quality of the nation's diet). This is important given the rise of obesity and malnourishment even in the presence of adequate food production levels. Part of the analysis will seek to document shifts in crop production at the state-level over time, including the roles of population pressure on land as well as shifting climate belts. We will also examine the diet quality of different ethnic groups over time, and during economic shocks, such as Covid-19.
5. Build regional capacity and facilitate the integration of research and outreach. To support the integration of research into practice, in the spirit of the Northeast Agenda 2023, we will support the infusion of DEIJ principles into extension programs wherever possible, and ensure that community development professionals in the region, whether or not they have this responsibility in their formal position title, have access to state-of-the-art research and training materials, including DEIJ and impact measurement tools.

Methods

1. We will estimate state-of-the-art statistical models using confidential data from the Penn State Federal Research Data Center (RDC) on the growth characteristics, survival constraints and opportunities facing female and ethnic minority entrepreneurs in the Northeast region. Collaborating faculty in WV, ME, PA, at 1890 institutions and the Economic Research Service, among others, will be critical to carrying out the objective by providing guidance and model specification, analysis, publication and dissemination of results. The individual level data will be tied to specific counties allowing us to assess how both individual and contextual as well as spatial clustering factors affect entrepreneurial success. Typical regression models will be of the form $Y = a + bX + cZ + e$ where Y is some outcome variable such as profit or employment growth, X is a set of county level characteristics such as the rural-urban continuum score or population density as measures of market access, natural amenities, existing business services and agglomeration factors, among others. Z denotes a set of entrepreneur-specific variables such as gender, age, ethnicity, education, industry sector and others. We will used appropriate statistical techniques such as limited dependent variables models or spatial error and spatial lag specifications as necessary. Also, as necessary we will explore the use of instrumental variables or synthetic control methods. Bayesian methods of analysis will be used in cases of modeling uncertainty (e.g., Gelman et al., 2013, Schmidt et al. 2024). In certain specifications we will also use data collected at different points in time, so that the dependent variable Y can be measured over time as a log or percent change (dY), and the initial or starting value of Y is included as a control variable among the regressors, allowing for explicit tests of convergence. This will allow us to assess the effect of economic and other shocks, such as recessions or the Covid-19 pandemic on food system and other entrepreneurs, including those operating breweries, wineries, distilleries or cideries. We will also explore the measurement and use of entrepreneurial ecosystem-type variables at the county level. This will include both labor force characteristics and the availability of services, such as bank branches, adult and childcare service facilities, or broadband availability. We will use caregiver data collected in collaboration with the North Central Regional Center for Rural Development and also use secondary public data such as that collected in the Household Pulse Survey. Institutional variables such as the Community Reinvestment Act designation will be considered as well in terms of their impact on outcome variables such as access to credit. Policy variables from the USDA's Economic Research Service and natural indicators such as the Amenities Index and the new Ruggedness measure also will be considered.

2. In collaboration with the Outdoor Recreation Group, formed in response to the release of the USDA NIFA-RD-FS MOU, we will model and analyze barriers and constraints facing various tourism destination management organizations (DMOs), and also provide training for lagging regions that have not yet taken advantage of their natural resources, including agritourism opportunities. The primary methods of analysis will include county-level data over time, so that the impact of different shocks on resilience can be evaluated both in the short and long terms. In the initial phase we will conduct spatial analyses to assess overlap in the service areas of NIFA, the Forest Service, and Rural Development, in order to identify priority locations for interventions. Here collaborations with expert faculty in WV, ME, NH and VT among other states will be critically important to the successful implementation of the objective. In addition to using secondary data, we anticipate collecting primary survey data to specifically identify key challenges, priorities, and resource needs of DMOs. We will use appropriate stratifications in order allow comparisons among different tourism destination to facilitate the identification and sharing of best practices across different locations. For example, well-known destinations such as the Acadia National Park in Maine are challenged by over-tourism and need programs to better support tourists while managing visitor numbers in sustainable ways. Other locations, such as PA Wilds and selected individual counties such as Wyoming, PA in rural Pennsylvania (https://www.nicholsonheritage.org) do not yet have the scale needed to attract a large number of diverse tourists; in fact, they often face a chicken and egg situation where the services are not forthcoming because tourists are few in numbers, and the number of tourists is limited by a lack of attractions and leisure and hospitality services. Here the challenge is for individual counties and regions to collaborate and cluster in breaking out of the dilemma. With careful comparisons and models of different communities based on secondary data and custom surveys, we expect to be able to identify best practices to help different types of communities grow to scale. On the agritourism side, we will use secondary data analysis to evaluate the impact of agri-tourism on local community indicators. For example, we will estimate regression models of the form $Y = a + bX + cZ + e$ where Y is some community level outcome such as farm income, local income, poverty or employment growth, X is set of county level economic or farm conditions (such as livestock vs. crop agriculture), broadband availability, ease of access, population density or distance to major metropolitan areas, which control for local context. In this specification, Z is a measure of agritourism, such as the number of farms offering such services, or the income earned from providing the services. Using time series data, it will be possible to assess the impact of different kinds of shocks on tourism revenues and resilience.

3. We plan to use secondary data, including input-output tables to begin to assess the potential for building green energy related supply chains in the northeast states, along with their impacts and the factors contributing to their emergence. Using state-level data on greenhouse gas (GHG) emissions over time available at U.S. Energy Information Administration (EIA, https://www.eia.gov/environment/emissions/state/), we will document how different states are managing the transition to green energy, along with the contributions of different industrial sectors to carbon dioxide emissions. The use of satellite-based carbon emission sites will also be explored, as a means of verifying and complementing the survey-based data. We propose to use existing public data, as well as the new Census Bureau's Annual Business Survey (ABS) (https://www.census.gov/programs-surveys/abs.html), to identify barriers to and opportunities for firms both to adopt and to generate green energy in their production facilities. This modeling will include state, county and firm-level analyses of changing greenhouse gas emissions over time, including the impact on different racial groups and different business types, including farms. We will combine firm level and county level secondary data in the analysis. More specifically, identifying where carbon-intensive industrial activity occurs is critical for understanding possible routes to a low-carbon economy, and for identifying impacts on communities and workers. We propose to use microdata from the 2014, 2018 and 2022 Manufacturing Energy Consumption Survey (MECS) (EIA 2015, 2019 and 2023) to estimate the carbon performance of individual establishments across all manufacturing industries, examine the locational characteristics of these various establishments, and test hypotheses about the locational (community) characteristics most conducive to carbon-intensive activity. The MECS provides comprehensive data on all forms of energy used by manufacturing plants during the reference year. By applying an emissions factor – a coefficient produced by EPA that describes the rate at which a given energy type releases greenhouse gases into the atmosphere – to these data we can accurately estimate emissions from each plant (Boyd and Lee 2020). Normalizing carbon emissions by total revenue or employment allows comparisons of carbon performance across establishments. Employment and payroll data for the MECS firms will be merged with the Longitudinal Business Database (LBD) using firm specific identifiers. Revenue is not available in non-Economic Census years (2014 and 2018) but can be imputed using payroll to revenue ratios by detailed industry in the nearest Economic Census year. An OLS regression of carbon performance provides information on the factors contributing to carbon performance at the mean. However, testing hypotheses of factors associated with high emissions plants requires quantile regression that can examine associations throughout the carbon performance distribution. The hypothesis that disadvantaged areas are more likely to attract more polluting industries has been well researched in the environmental justice literature (Mohai et al. 2009; Goetz and Kemlage 1996) but the evidence with respect to rural areas is much thinner (Cohen 1997). Testing the effects of population density, land values, topography, and socio-economic disadvantage on carbon intensive activities will provide information on where the challenges and opportunities with respect to the low-carbon transition are greatest.

Logistic regression with bias correction for rare events as proposed by King and Zeng (2001) is well suited for estimating the probability of rare events, especially when the sample size is large as is the case here. In addition to 300,000 firm level observations in the 2022 American Business Survey (ABS), multi-unit firms have each of their establishments included in an establishment file with roughly 2.2 million observations. The establishment file contains only rudimentary information such as NAICS industry, location, and employment size. However, these data are sufficient to test the central hypotheses of the associations between location characteristics and reported renewable energy R&D and use at the firm level. We will use the 2022 ABS data to estimate the following logistical regression equation: $Prob(Renewables\ R\&D=1) = b0 + bX + e$ where suppressed index i and j denote firm and county, respectively and the X are the following regressors: establishment age, firm size, publicly held company status, intent to eliminate, replace or reduce carbon emissions, 2030–2050 decarbonization goals, environmental innovation, strategy failure risks, climate shock, FEMA climate shock, republican vote 2020, socio-economic level, population density, land value, natural amenity scale, solar energy potential, average wind speed, ruggedness, transmission access, airports, land cover, decarbonization actions, and industry fixed effects. A similar equation replaces R&D with renewable energy use as the dependent variable. As noted, a simple logistic model using maximum likelihood estimation for rare events is biased, so we use the bias-corrected approximate Bayesian estimator in King and Zeng (2001). We will use firm and county (X) controls to identify factors at each level that are correlated with R&D on renewables and the use of various forms of onsite renewable energy. Firm-level variables of interest include the industry (given by the NAICS code), firm size (question A.8), and revenue (question A.11). County-level controls will include factors that encourage or discourage renewable energy siting, many of which come from previous studies (e.g., Hitaj 2013) and ongoing work from Justin Winikoff at the ERS. Key variables will include transmission access, renewable (solar and wind) potential, land values and existing renewable energy development. Controls will also include key variables measuring rurality in various ways, such as population density and the amount of undeveloped land suitable for renewable energy. Critically important under this objective will be a collaboration with the National Extension Climate Initiative (NECI), currently chaired by Dr. David Kay of Cornell University. Successfully modeling the determinants and impacts of shifting to green energy also requires local, state-level knowledge of communities, preferences, and policies, for example in NY and NH, so that a multi-state approach is required.

4. Using public data, including from the Household Pulse Survey as well as other sources, we will examine how the food security and quality situation of different households stratified by ethnicity and income was affected by Covid and its aftermath, including the effect of public covid support payments. We will use agricultural Census and NASS historical data to document the production of different crops and related products over time and compare the region's contributions to those of the nation. Shift share analysis will be used to identify the contribution of competitive factors in crop acreage growth or decline. We will use proprietary grocery store scanner data (IRI) to calculate household level diet qualities indices and public secondary data to model and assess differences in population health at the county-level.

Following Loveridge and Selting (1998) and Artige and van Neuss (2014) who discussed an assortment of variation in the shift-share formulation, we apply the most basic approach to computing shift-shares for crop production (Dunn Jr., 1960). The shift-share analysis decomposes the total change in crop production into three components: (1) a national growth effects: the amount of all crops of a state would have grown or decline if it had changed at the same rate as the nation; (2) a commodity mix effect: the amount of change attributable to differences in the commodity makeup of a state versus that of the nation (we use the term of commodity mix effect to replace the industry mix component in the original shift-share definition). (3) a competitive effect: the amount of local crop production changes not attributable to national growth or commodity mix effects. A positive competitive effect for a particular crop indicates competitive advantages in its production. With the crop-specific shift-shares, we can examine the comparative advantages in producing specific types of crops, for example, using the four-cell table analysis. To explore economic and natural drivers for the shifts in shares, we regress each component of the shift-share change for individual crops separately on the growth of personal income, population density as a proxy for land costs, precipitation and drought variables, and others.

5. This objective will be achieved though zoom meetings organized around specific topics corresponding to the different objectives, as well as a wide variety of outreach materials for peer reviewed research findings, including factsheets, infographics, bulletins, and short reports. In selected cases and for certain objectives, such as for the results that will be of interest to DMOs, we will prepare data dashboards containing information in as close to real time as possible. For county leaders we will also provide informational materials related to decarbonization and entrepreneurial growth conditions, some of which may be presented in the form of dashboards. Communicating the relevant research results generated both by the Center and collaborators both to the region and beyond, including policymakers, is a priority. A multi-state approach is essential not just for ensuring that state differences in policies and conditions are reflected in the research, but also for widespread distribution of results to where they are most needed.

Measurement of Progress and Results

Outputs

- The most common type of output will be in the form of peer-reviewed scientific publications, the results of which will be shared at conferences, workshops, and Congressional briefings, as appropriate, and once “translated” also serve as the basis of lay audience-friendly information and outreach materials, including webinars, factsheets, data dashboards and press releases. These outputs are expected to be of value to stakeholders or end users in making critical day-to-day decisions, whether they are in the public, nonprofit or private sectors, including on farming operations. Specific metrics include scholarly citation counts, audience members reached or attending webinars, media mentions, and references to the results in media such as newspapers or social networks, and invitations to present findings at conferences and selected audiences.
- In addition to curating and presenting publicly available state- and county-level data sets both in tabular and in mapped formats, we will make the deidentified data from the caregiving survey available on our website for others to use; this may include faculty, educators and graduate students interested in the conditions surrounding caregiving. In addition, we will present basic descriptive statistics from the survey, pending data cleaning and analysis. This and other data sets will benefit end user-stakeholders directly, and other products such as the maps will help end users visualize conditions over rural space and how these are changing over time.
- Another tangible output is the networks of researchers and educators convened around specific pressing problems and issues arising in the rural Northeast. One component of this capital will be the post docs and graduate students trained over the life of this project. Members of the networks will benefit directly from the network effects including the sharing of resources, insights, and information while the students will be better prepared to take on employment in academia or the private sectors. Metrics tracked here will include supplemental grant funds secured and other indicators that the results presented resonate with stakeholders (e.g., “upvotes” on Reddit). We will track emerging collaborations with faculty and educators in the Northeast region, as well as networks formed as a result of this work.

Outcomes or Projected Impacts

- One key set of projected impacts is the improved social and economic outcomes in rural communities, for both businesses and individuals. For example, Destination Management Organizations in congested tourist areas will better manage the influx of tourists, while communities that are unable to attract enough tourists to achieve a minimum efficient scale will collaborate with surrounding communities to develop a more viable tourist economy. Similarly, agritourism communities and related offerings such as beer or winery trails will be more economically vibrant. Areas known for high levels of greenhouse gas emissions will be moving towards a path of decarbonization, using the insights generated in this project from the analyses of secondary public data.
- Decisionmakers in the public and private sectors will have a better understanding of the various constraints facing small entrepreneurs, including across ethnic and gender lines. These are expected to reflect market and credit access, broadband and services such as child or adult daycare. They will be provided with the tools and resources needed to address these barriers.
- Ultimately, better physical and mental health outcomes, and lower poverty and higher, more equitable income growth over time as reflected in secondary, publicly available data, are key expected impacts of this project.

Milestones

(**0**):A first milestone will be reached when the data needed to carry out the statistical work under objectives 1 to 4 have been extracted, verified and compiled into appropriate software, such as Stata or R. In general, we expect this to take no more than one year for the publicly available data, although accessing the highly confidential data in the federal Research Data Center may take longer. In parallel, this first milestone will include the forming of objective-specific groups of multi-state collaborators.

(**0**):The second milestone will be reached once the data have been analyzed, written up in reports, and submitted for peer review to scientific journals. Across the three objectives, we expect this to take from two to four years. In parallel to this milestone, we will have formed networks of researchers and educators around specific objectives and sought additional funding to leverage, extend and deepen the work compiled to this date. We will also have started to disseminate peer-reviewed research results through various media by the time this milestone is reached.

(**0**):The last milestone will be reached after the outreach materials have been prepared, reviewed and distributed through various print and in-person venues through year 5 of the project.

Outreach Plan

As noted above, outreach is a critical objective (no. 5) of the project itself and includes various forms of printed materials as well as webinars providing further detailed information. Given the extensive networks that the Center already has in place, we expect the results to be defused widely, including to the stakeholders in the individual states of the Northeast U.S., for example through faculty and Extension educators. We also expect to share results with our key funders and elected representatives in Congress. The Center also produces an annual report and a quarterly newsletter (appearing with greater frequency, as needed).

Organization/Governance

The Center is funded through multiple sources including a directed or prime grant from NIFA, competitive grants, Hatch Multistate Research Funds (NERA funding), and state funds and, from to time, private foundation funds. This proposal is directly related to the Hatch MRF. The Center is led by a director who works closely with faculty and educators both in the region and, through the other RRDCs, nationally. In addition, The Center is guided by a technical advisory committee and is governed by a Board of Directors, comprised of Northeast land grant university Deans or Directors.

Collaborators

Technical Advisory Committee members (tbd)

David Abler, Ph.D., Prof. of Ag, Env. & Reg. Econ. and Demog., Interim Head, AESE PSU

Andrew Crawley, Ph.D., Assistant Professor, School of Economics, Univ. of Maine
Heather Stephens, Ph.D. (Chair), Assoc. Prof. and Director, RRI, West Virginia Univ.

Doug Arbogast, Ph.D., Rural Tourism Specialist, West Virginia University

Adam Hodges, CED Program Leader, West Virginia State University
David Kay, Senior Extension Assoc., CaRDI and Dept Development Sociology, Cornell U.
Shannon Rogers, Ph.D., Associate Extension Professor, Univ. of New Hampshire

Andy Wetherill, Adjunct Professor and Agribusiness Specialist, Delaware State Univ.

Peter Wulfhorst, ECD Educator, Penn State Extension, Pike County

Zheng Tian, Assistant Research Professor, NERCRD, AESE Penn State

Claudia Schmidt, Assistant Professor and Extension Specialist, AESE Penn State

Other faculty and educators in the region, as well as nationally, tbd.

Counterpart Regional Rural Development Centers and their staff (generally topic-specific)

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Land Grant Participating States/Institutions

Non Land Grant Participating States/Institutions

Participation

Participant	Is Head	Station	Objective	Research						Extension	
				KA	SOI	FOS	SY	PY	TY	FTE	KA

Combined Participation

Combination of KA, SOI and FOS	Total SY	Total PY	Total TY
Grand Total:	**0**	**0**	**0**

Program/KA	Total FTE
Grand FTE Total:	**0**

NERCD MS HATCH
Proposed budget
9/1/2024-8/31/2025

Salary		
PI-Goetz	$22,400	
Associate Director	$4,000	
Business Manager-Boonie-	$10,400	
Communication Specialist-Devlin-	$13,800	
Assistant Research Professor-Tian	$8,836	$59,436
Fringe		
		$21,338
Supplies		$826
Travel		$18,400
TOTAL		**$100,000**

NERCRD NE19139 Regional Hatch Project; February 23, 2024

NERCRD Regional Hatch Project Request – supplemental materials

1. Summary of matching from other sources of support for annual NERCRD operations

The following are annual averages over the last 5 years:

$549,424	NERCRD core funding from NIFA
$195,293	Other, competitive grants from NIFA (both as PD and as subcontractor with grants received together with colleagues in the region)
$123,232	Other NIFA funding (Extension Smith Lever, multi-state research, other)
$79,393	From State sources
$59,942	PSU in-kind F&A on core funds, PSU College of Ag competitive grants (SAFES)
$40,788	NERA off-the-top funding (this amount has been in place since before 1999)
$1,048,072	**Annual Total average, last 5 years**

2. Budget Justification for requested funding increase from $40,788 to $100,000

We request an increase in the amount of **$59,212** as follows:

$21,338	for fringe on salary that was previously covered by the College of Ag at Penn State but is no longer covered
$18,400	to support travel by project participants to the annual project meeting
$19,474	to compensate for salary inflation since 2000 (we are requesting a 45.7% increase, compared to an actual rate of inflation of 82.7% to 2024)[1]
$59,212	**Total requested increase**

1. According to the Bureau of Labor Statistics' current inflation calculator, (see: https://www.bls.gov/data/inflation_calculator.htm) the rate of inflation from January 2000 to January 2024 was 82.7%. The requested 45.7% increase in salaries is calculated as $59,436/$40,788, which is the new requested salary amount relative to the long-term former off-the-top funding amount, all of which was spent on salaries.

NERCRD NE19139 Regional Hatch Project; January 11, 2024

Budget Justification

Salaries ($59,436):
Funds are requested to support faculty and staff time to work on research and coordination activities related to the five project objectives. For faculty this will include collection of preliminary data and other research efforts to establish feasibility of specific sub-activities related to the project objectives. For staff time, this will include meeting logistics (including zoom calls) as well as communications and dissemination of research results.

Fringe ($21,338) is calculated at the Penn State rate for FY 2024.

Supplies ($826): for project related efforts, including postage and printing, factsheets and short reports.

Travel ($18,400): to support travel of project participants to meetings at location(s) in the Northeast to be determined in furtherance of project goals (e.g., to work on new grant applications on specific topics). Estimated: 14 individuals at $1,314 travel and lodging expense average per individual.

Total requested: $100,000

From:	Gary Thompson
To:	Rick Rhodes; Bret Hess; Jeanette Thurston; Alton Thompson; Christina Hamilton; Jennifer.Tippetts@WAAESD.org; David Leibovitz; Lisa Williamson
Cc:	Steven Lommel; Cindy Morley
Subject:	NRSP3 Renewal - Regional Spring Meetings
Date:	Thursday, February 29, 2024 12:51:06 PM
Attachments:	image002.png

Colleagues,

As you prepare for your regional spring meetings, please consider adding NRSP3 as a topic on your business agendas. NRSP-RC will be considering the renewal application for NRSP3 and regional input is very much appreciated in the committee's deliberations over the merits of the proposal. Below are links for materials submitted for the proposal.

Proposal to Renew NRSP3
NRSP_temp3: The National Atmospheric Deposition Program (NADP) (homepage link: https://nimss.org/projects/19113).
Reviews https://nimss.org/review?project_number=NRSP_temp3
Post-review Version: https://nimss.org/storage/10958/NRSP-3-Proposal-Application-(Version-2-post-review).pdf
Budget: https://nimss.org/projects/nrsp_budget/view/19113

Please contact me if you have any questions.
Thanks.

Gary

Gary A. Thompson, Ph.D.
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Southern Association of Agricultural Experiment Station Directors
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NRSP_temp3: The National Atmospheric Deposition Program (NADP)

Status: Under Review

Duration	10/01/2024 to 09/30/2029
Admin Advisors:	[Douglas Buhler] [Jason C White] [Kang Xia] [William Payne]
NIFA Reps:	

Non-Technical Summary

The National Research Support Project-3 (NSRP-3) is a long-term project designed to provide research quality data to SAES scientists to address many national needs, agricultural grand challenges, and research needs. Our primary goal is to measure the rate of pollution deposition onto U.S. agricultural lands (i.e., pollution falling onto the surface with precipitation). We measure the deposition rate of sulfate, nitrate, ammonium, chloride, major cations, and H+ (pH) at over 250 locations, and ammonia gas concentrations at 100 sites to estimate dry deposition (through gravitational settling). These measurements are made weekly/biweekly and with standard methods at all sites, and principally for research purposes.

Our data is provided in weekly measurements, monthly, seasonally, and annual averages, is quality assured, and is all available free of charge (see https://nadp.slh.wisc.edu/). This data is used for research, policy decisions and education (primary to graduate). Agricultural scientists use our data in many different types of research; a few examples include understanding chemical movement (nitrogen, other) associated with fertilizers and animal feeding operations, basic data for many agricultural models to understand new techniques and estimate environmental impacts, for evaluating ammonia emission impacts on non-agriculture environments, trends determination over time, etc. Many other nonagricultural scientists use our data as well. Our results are used in approximately 200 journal articles per year, meeting the NRSP research support role.

Finally, NRSP-3 funding is highly leveraged with other federal, state, and tribal agencies, and other groups to provide this national scale data for all scientific purposes and research.

Statement of Issues and Justification

Prerequisite Criteria

How is the NRSP consistent with the mission?

National Research Support Project-3 (the National Atmospheric Deposition Program, or NADP provides a national and international monitoring cooperative to measure the flow of air pollutants into all managed agricultural systems and all other environments over the United States and Canada. Through this cooperation, a research database of pollutant concentration measurements in precipitation and downward fluxes has been developed (since 1978 and at 251 current sites), which supports significant and important agricultural research in several specific areas (collection, assemble, storage, distribution, information, etc.). This cooperative approach directly supports the NRSP mission, by providing basic chemical measurements of sulfur, nitrogen, chloride, and other cations into agricultural systems for researchers to use. All of these compounds are or could be important in many agricultural settings, so the NRSP-3 thereby supports a wide array of agricultural research activities in any number of ways (e.g., Grand Challenges, see below) and supports many other types of environmentally-connected research simultaneously.

NRSP-3 provides a collaborative framework for participating scientists from State Agricultural Experiment Stations (SAES); universities; federal, state, local, and tribal government agencies; national forests and laboratories; environmental institutes; private companies; and other research organizations who cooperate in sponsoring NADP measurement networks. We support the NRSP mission by providing agriculturally-related data that can be used at any and all SAES, any land-grant university (1862, 1890, 1994), and allows for SAES/agricultural scientists to cooperate more easily with researchers from different departments, colleges, universities, and government institutions. Finally, this data is provided to researchers free of charge.

The NADP provides the only regional and national-scale data and information on the amounts, geographic distribution, and trends in chemical deposition by precipitation in North America. The NADP operates five networks which support differing research goals and areas of interest. For this proposal, the agricultural community primarily cooperates in two large networks: the National Trends Network (NTN) and the Ammonia Monitoring Network (AMoN). Specifically, the NTN provides weekly concentrations in precipitation of free acidity (H^+ as pH and concentration of this ion), specific conductance, nitrate (NO_3^-), ammonium (NH_4^+), sulfate (SO_4^{2-}), calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+), potassium (K^+), and chloride (Cl^-). The AMoN provides two-week atmospheric concentrations of ammonia gas (NH_3). These compounds are important for agricultural research and therefore can be used in any number of research areas and projects, as is shown year in and year out in our output statistics and project results.

The NRSP-3 research database of these two networks (NTN, AMoN) now includes over 600,000 measurements of precipitation chemistry, extending from 1978 to mid-2023. Each of these records has an observation of each previously listed chemical component, the amount of precipitation for the week, a valid or invalid measurement determination, and a date and time of the measurement, all for over approximately 300 monitoring locations. Finally, the 53 SAES-associated stations have the longest continuing records since most of these sites were the original NRSP-3 sites in the network. Almost all these sites have 40+ year historical records.

Distribution of NRSP-3 data is through a web-accessible database, where **all** scientists and data users have access to all data available, meaning no data or information is sequestered. It is a truly publicly available database for anyone to use (research, education, or policy, see https://nadp.slh.wisc.edu/).

The NRSP-3 has demonstrated flexibility and response to the current and future national needs of the research community for information over a broad array of scientific topics. These topics include the effects of atmospheric deposition on terrestrial and aquatic ecosystems, biogeochemical cycling, climate change, and human health. NRSP-3 data support informed decisions on air quality issues related to precipitation chemistry and atmospheric deposition. NRSP-3 also directly supports the Grand Challenges of the *Science Roadmap for Food and Agriculture* (1), and particularly Grand Challenge 1, 2, 3 and 6, and partially 4 and 5. In general, NRSP-3 information has been invaluable in:

- Documenting the presence and removal of inorganic pollutant gases and aerosols in the atmosphere (i.e., the United States' "chemical climate");
- Documenting how atmospheric chemicals are changing in amount and relative composition over time (trends determination);
- Understanding the effects of atmospherically-deposited chemicals on agricultural crops, national and state and private forests, rangelands, surface and ground waters, estuaries, aquatic impoundments, and other natural resources;
- Documenting the flow of agricultural nitrogen, evaluating new agricultural methods to control the release of nitrogen from cultivated fields and crops into waterways and the atmosphere, tracing gaseous ammonia emissions and movement from agricultural operations, satellite-based tracking of NH_3 in the atmosphere from source to sink, and used in many other agricultural modeling efforts;
- Assessing the accelerated weathering of material and cultural resources resulting from atmospheric chemical deposition;
- Discerning pollutant sources and source distributions and their relationships to deposition (i.e., source-receptor relationships); and
- Evaluating the effectiveness of current Clean Air Act (CAA) legislation and subsequent rules promulgated under the act, and the impact of atmospheric deposition on water quality requirements set by the Clean Water Act.

How does the NRSP pertain as a national issue?

Rationale

Priority Established by ESCOP/ESS

NRSP-3 directly supports the Grand Challenges of the *Science Roadmap for Food and Agriculture* (1), and specifically Grand Challenge 1, 2, 3 and 6. NRPS-3 also supports Challenges 4 and 5.

Grand Challenge 1 "*We must enhance the sustainability, competitiveness, and profitability of U.S. food and agricultural systems."*

The NRSP-3 directly supports to sustainability and profitability of the U.S. food and agricultural system. This support is provided by:

- NADP supports sustainably of the food system, through the monitoring of pollutants that are emitted from agricultural operations, and therefore promoting efficiency and reduction of environmental damage. One specific pollutant here is nitrogen pollution, and specifically ammonium, ammonia and organic nitrogen (this next year). We measure these compounds in both precipitation and as atmospheric gases, as detailed in many research activities pursued by agricultural scientists. Pollution of the surrounding environment is not a sustainable process, and agricultural scientists are studying new methods to control these emissions. NRSP-3 can monitor for the current emissions, and current observations can be used to monitor emissions over time to determine when the issue is becoming more sustainable (fewer impacts).
- NADP has a role in the monitoring of N loss from animal feeding operations and waste facilities (ammonia, organic nitrogen), and tracking the impact upon the surrounding environment.
- NADP supports competitiveness and profitability through an increase in nitrogen use efficiency and less loses of nitrogen to the environment.
- NADP also monitors for some of the phosphorus compounds, heavily used in agricultural operations (fertilizers), by measuring the growing amount of P in the atmosphere and in deposition, leading to research designed to reduce the presence of phosphorus.

Grand Challenge 2 "*We must adapt to and mitigate the impacts of climate change on food, feed, fiber, and fuel systems in the United States.*"

- NRSP-3 monitors climate and climate change by monitoring precipitation at approximately 300 sites across the U.S. Therefore, we monitor one of the principal factors of climate change (e.g., precipitation changes).
- As precipitation changes occur, the "chemical climatology" will likely change. Concentration of pollutants is a direct result of the volume of precipitation, and changes in precipitation (volume) will result in chemical concentrations in the atmosphere. The same is true for deposition rates, which are based on the amount of precipitation that falls. If precipitation depth changes, then deposition rates also will change.
- The above two changes will result in a change in chemical flow to the agricultural lands of the U.S., and NRSP-3 is in place to measure any differences that can be attributed to changes in precipitation.
- Many atmospheric chemistry reactions are temperature dependent (e.g., nitrogen compounds). Many scientists expect higher levels of ozone in the atmosphere, which could accelerate the deposition of the resulting pollutants. NADP measures some of the resulting compounds from ozone reactions.
- With expected increasing temperatures, more cooling will be needed (in U.S. and abroad), and in much of the world, the electricity demand will be met with increasing combustion of coal/natural gas (i.e. India, China). Coal contains many of the pollutants that we measure (e.g., S, N, mercury), and with increasing cooling, a result should be an increase in the deposition of these pollutants. NRSP-3 will be used to track these changes.
- Wildfires and prescribed burns are expected to continue to increase under warming/drier climate scenarios. The NADP's long-term data record can be used to assess the impacts from smoke, biomass burning, carbon cycling, and other disturbances on air quality and agricultural systems.

Grand Challenge 3 "*We must support energy security and the development of the bioeconomy from renewable natural resources in the United States.*"

- By tracking the movement of S and N compounds, we are documenting the change in atmospheric chemistry and deposition to lands, as the evolution of increasing energy production and electrical needs move from coal based (high S content) to natural gas (low S content) and biofuels.
- As biofuel research and production begins, this will include combustion of compounds within the biofuels (S, N, P, etc.), and any changes in the wet deposition from these activities will be monitored and recorded by the NRSP-3.
- As biofuel production begins, this will require adaption of agricultural procedures and these adaptations could have impacts upon deposition to surrounding environments. The NRSP-3 will be in place to measure any increases or *decreases* of these impacts.
- With the increased electrification of the transportation fleet, more power will be needed. These transportation emissions will be transferred from urban corridors (vehicles) to rural locations where the production of electricity is generated from biofuels. If any change and movement of these pollutants should occur, NRSP-3 will record that signal, providing required information for agricultural researchers looking for impacts from these changes.

Grand Challenge 4 "*We must play a global leadership role to ensure a safe, secure, and abundant food supply for the United States and the world."*

Work done in the past has shown the movement of agricultural diseases through the atmosphere. If these diseases are water soluble, the NRSP-3 can be used to show their movement, as we did with Asian Soybean Rust spores. NRSP-3 could be used to monitor movement of any number of biological bodies, spores, etc. In the past, we have proposed to use the assets of the NRSP-3 as an airborne crop disease monitoring network. The NRSP-3 is a network for observation network (infrastructure, sampling media, site operators), and the right scientific techniques allows this observational data to be used for many different agricultural applications.

Additionally, the NADP data could be used to monitor the increased use of fertilizer and herbicides/pesticides, which are all likely to be required with increasing food needs. Herbicides/pesticides have been found in precipitation, and NADP could be used for this type of network (given other quality assurance considerations) with scientific support from our members.

An open agriculturally related network also will allow for easy applications of these types of approaches with the scientists of the SAES system.

Grand Challenge 6 "*We must heighten environmental stewardship through the development of sustainable management practices."*

It seems rather obvious for Challenge 6 that almost every research article using our data are focusing on this Grand Challenge. This is true for the overwhelming majority of the approximately 1000 articles have used NRSP-3 data in their research over the past five years (see https://nadp.slh.wisc.edu/pubs/Annual-Data-Summaries/). It is the case that all the articles mentioned in this proposal supports this Grand Challenge.

Other Challenges Addressed: This listing of grand challenges addressed by NRSP-3 does not discuss the issue of mercury contamination of the soils and fish or the impact to the health of the nation. The three NRSP-3 networks concerned with the movement of mercury (Mercury Deposition Network, Atmospheric Mercury Network, Mercury Litterfall Network)do provide meaningful research data direction to address the Science Roadmap Grand Challenges 4 and 5, concerning health of the national food supply (e.g., mercury moving into the food chain of fish). Fish are principally harvested, but aqua culture is increasing in importance. Fish consumption is important to many subpopulations, particularly coastal states, and native American subsistence populations.

Overall, one of the principal advantages of the NRSP-3, is that it is a science-based observation network. With its structure, scientific direction, and site locations around North America, the NRSP-3 can be used to make many fundamental measurements in a wide variety of ways to measure the temporal and geographical impacts of both chemical and biological effects in support of agricultural research. It is structured for agricultural scientists to make these needs known and to test these ideas out relatively quickly through the NRSP designation.

Relevance to Stakeholders

NRSP-3 provides a collaborative environment to leverage the fiscal, material, human, and intellectual resources of scientists, educators, and policymakers from SAES, universities, government agencies, and non-governmental organizations. Stakeholders include:

- Sponsors that pay for NADP site costs, site operations, etc.
- Site operators contributing efforts in sample collection.
- Cooperators that provide land, electricity, laboratory/office space, and shipping.
- Scientists who use and present NADP data.
- Educators who use NADP data in their classrooms or textbooks.
- Students who use NADP data in the classroom or graduate studies.
- Policy makers who use NADP data to make informed policy decisions.

All program stakeholders are invited to attend twice-yearly subcommittee meetings in the spring and fall, (~ 75 individuals). Subcommittees receive status and progress reports on network activities, review operations and documents, consider procedure and equipment changes, and propose new initiatives. Many stakeholders are officers and ad hoc members of the committees and subcommittees. The NADP *Quality Management Plan* calls for triennial network laboratory reviews, with reviewers drawn from stakeholders.

The Executive Committee (EC) seeks to engage stakeholders in NADP activities. Recent interest has led to investigation of using the NADP to support citizen science, development of the Total N and P measurements, and the breadth of mapping by the Critical Loads (CLAD) subcommittee.

Since 2011, the Total Deposition subcommittee (TDEP) has developed a new map series of total deposition of N and S through a measurement and modeling “fusion”. TDEP has been vigorously updating their mapping series and continues to bring in new membership (see reference 37 and https://nadp.slh.wisc.edu/committees/tdep/).

In the last several years, Aero-allergens (pollen) have been stirring interest among several cooperators and a new scientific AMSC subcommittee was established (https://nadp.slh.wisc.edu/committees/amsc/). AMSC has brought in new members primarily from the health community, with intention of using NADP networks as a national atmospheric pollen monitoring network. This effort has made significant progress (38) with the possible use of new technologies in a network. This effort is of interest to many agricultural researchers, since there is a connection between pollen and agriculture.

Stakeholders in the research community can submit a simple proposal to use archived NADP samples for additional research. Researchers are encouraged to attend NADP meetings and present their findings. This has sparked new discussion and new research. Recent research studies include:

- Applying O^{18} and H^{2} measurements to examine the relationship between precipitation and surface and ground water sources. (39-41)
- Using N^{15} measurements to infer atmospheric NO_x sources. (42)
- Testing for the presence of potentially hazardous chemicals. (43-46)
- Investigating organic nitrogen inputs to total deposition.
- Measuring dissolved Si to understand loads to surface waters in the Midwest.

Stakeholder use of NADP data is assessed by recording website activity, requesting annual participant reports, and performing regular literature searches. This information is summarized in SAES-422 and USDA AD-421 reports.

Internet disbursement of precipitation chemistry and atmospheric data is the primary route of NRSP-3 data and information. From 2018-2022, NADP estimated over 20,000 measurement data sets were downloaded each year, and approximately 50,000 PDF map images and 100,000 map data sets (grid and kmz). As far as we know, downloads continue to occur at roughly the same rate over the last five years, suggesting that NRSP-3 remains relevant.

Each year, NRSP-3 summarizes research that develops in whole or in part from NADP data. During the last three years, publication counts have remained high relative to historic counts (since 2007) at about 220 per year. However, 2022 was rather low (183), which may be due to COVID-19 implications. Assuming 2022 was unusual, research use in publications remains consistent, and, again, signals that the NRSP-3 data remains useful and relevant for research support.

NADP data are frequently used to inform and evaluate environmental policies and agreements. NADP maps are utilized in US EPA materials for acid rain deposition and educational materials (https://www.epa.gov/acidrain), and total deposition values mapped by EPA's CASTNET (https://www.epa.gov/power-sector/progress-report-acid-deposition), and annual reports (47). Federal land management agencies also use this data for decisions involving regional haze, critical load estimates, general conservation, climate change decisions, and management of timber resources. NAPAP reports to Congress used NRSP data in assessing emissions changes on deposition on aquatic and terrestrial systems (48). The International Joint Commission uses NADP data in its periodic evaluations of the U.S.-Canada Air Quality Agreement (49) and the Canadian government's deposition assessments (50). Additional regional and state policy assessments, environmental impact statements, and numerous other reports use our data as well (https://nadp.slh.wisc.edu/pubs/nadp-bibliography/).

Each year, articles with agriculture importance are detailed in the NADP's SAES 422/NIFA REEport. Here are three examples from 2021 and 2022:

1. Zhang, J., Cao, & Lu, 2021. Half-Century History of Crop Nitrogen Budget in the Conterminous United States: Variations Over Time, Space and Crop Types. Global Biogeo. Cycles 35(10): e2020GB006876.

Crop nitrogen budgets are important to agricultural research, and the authors used multiple datasets to examine N budgets for eight major crops in the U.S. at county scale between 1970 and 2019. The authors concluded that N use efficiency has

increased from 0.55 kg N/kg N in the 1970s to 0.65 kg N/kg N in the 2010s. Corn, rice, cotton, and sorghum have increased in efficiency, while barley, durum wheat, spring wheat, and winter wheat have decreased. Iowa State University researchers used 16 years of national NTN nitrogen deposition data to estimate total N deposition for every county in the U.S.

2. Bhattarai, A., Steinbeck, Grant, Kalcic, King, Smith, Xu, Deng, and Khanal, 2022. Development of a calibration approach using DNDC and PEST for improving estimates of management impacts on water and nutrient dynamics in an agricultural system. Env. Mod. & Software 157: 105494.

The authors (Ohio State, ARS) focused on a modeling study of the biogeochemical DeNitrification DeComposition (DNDC) model in an agriculture situation in Ohio. The goal was to test three model calibrations to determine which was best. They also tested the effectiveness of the PEST parameter estimation software. Several model parameters were shown to be very influential, while corn yield was most sensitive to accumulative temperature and grain carbon to nitrogen ratio. The researchers used repeated years (2014-2020) of NADP's weekly data from a NE Ohio site (IN41).

3. Waiker, P., Ulus, Tsui, and Rueppell, 2022. Mercury accumulation in honey bees trends upward with urbanization in the USA. Ag. & Env. Letters 7(2): e20083.

With this very interesting idea, the authors theorized and found that honeybee (Apis mellifera) mercury concentrations, in part, were explained by the urbanization of the landscape. In their small sample, they did find that honeybee concentrations tend to increase with urbanization, although the low sample numbers. Methyl mercury (organic Hg form) was undetectable in the samples. The authors conclude that "urbanization may play a role in increasing Hg exposure to these pollinators", and honeybees could be a useful biomonitor for pollutants. The authors used seven NADP Mercury Deposition Network sites to associated mercury deposition to the concentrations in bees.

It is important to note that as of the last three months, we have started to build a new database system that will allow for searches of all of the publications that have used NADP data. This is complete for the 2022 year (https://nadp.slh.wisc.edu/pubs/bibliography_search/), and over the next several months we will collect and add the previous years starting in 2007, and will add the 2023 publications after the year's end.

Of special note is the particularly important role that SAES and off-the-top funding plays in NADP. The SAES funding provides three very important advantages:

(1) it enhances the ability of the SAES to address pressing needs of agriculture,

(2) it controls NADP site loss due to lower costs for SAES participation, and

(3) it leverages SAES funding by allowing participation of other federal and state agencies.

All NADP sites pay a management fee for operations. The SAES funding pays some of this fee for the SAES sites (evenly divided, essentially applying a "discount" to each site). The remaining costs are borne by the individual SAES. With a loss of NRSP status, the operational costs at all sites would increase significantly and many sites located in the agricultural production areas could potentially be shut down.

Implementation

Objectives

1. Characterize geographic patterns and temporal trends in chemical or biological atmospheric (wet and dry) deposition
2. Support research activities related to: (a) the productivity of managed and natural ecosystems; (b) the chemistry of surface and ground waters, including estuaries; (c) critical loads in terrestrial and aquatic ecosystems; (d) the health and safety of the nation's food supply; and (e) source-receptor relationships
3. Support education and outreach through the development of informational materials and programs aimed at people of all ages.

Projected Outcomes

- NADP provides timely deliverables of data free of charge. Stakeholders are encouraged to access data from the NADP website (http://nadp.slh.wisc.edu/). Comments: This site offers on-line retrieval of individual data points, seasonal and annual averages, trend plots, concentration and deposition maps, reports, manuals, educational brochures, and other information about NRSP-3. Quality-assured data and information from all networks are loaded quarterly into the on-line database system with a lag of ~180 days. Information available from this website and linked database management system constitute the deliverables that support the project objectives. NADP addresses special request data products, answers scientific questions, and assists users to find related information. Complementing the on-line data and information are publications such as annual data summaries, annual meeting proceedings and presentations, quality assurance documents (e.g., QMP), manuals, informational and educational brochures, and reports. All publications are available online (http://nadp.slh.wisc.edu/lib).
- To assess the type and amount of research activity supported by NRSP-3, participants are asked to annually report their program activities and publications that use NADP data. Comments: Additionally, information is obtained from online literature repositories to locate all publications that reference or use NADP data, maps, and other information. These are summarized annual and provided on the NADP website (http://nadp.slh.wisc.edu/lib/bibliography.aspx), providing for a testable deliverable. More than ~95% of these publications are peer-reviewed journal articles and reports, and also includes masters and PhD theses and dissertations covering a vast range of research areas. The balance includes informational pieces, such as newspaper reports. Over the last three total years (2020-2022), publications listed have numbered 217, 223, and 183 publications, respectively. This demonstrates that NRSP-3 is achieving the primary goals of NRSPs, namely, to support research (and NADP's Objective #2).
- Program Improvements and advancements Comments: Objective (1) was changed during the 2002-06 funding period to "chemical or biological atmospheric (wet and dry) deposition". This objective now explicitly mentions wet and dry deposition, including the (biological) deposition of plant pathogens and pollen. Current networks measure air concentrations of ammonia and mercury make possible the estimation of dry deposition fluxes and builds new research support capacity. Research activities under objective (2) were amended to address emerging interest in critical loads and the health and safety of the nation's food supply (mercury). During this period, a large part of the network changes have been towards monitoring for more N compounds (agricultural needs), and Black Carbon in precipitation (understanding trends and spatial distribution of pollutants from wildfires, relating NADP directly to climate) and PFAS compounds (discussed elsewhere). In summary, a focus of providing more data with the same activities/measurements increases the value of the network. We feel that we have met all our goals for the current period and the previous year, and that all of our data was in place on time and used for research in many different agricultural areas. We can always make better use of our assets and will strive to continue to improve.

Management, Budget and Business Plan

Project Management and Business Plan: Project management of NRSP-3 is described in the *National Atmospheric Deposition Program Governance Handbook* (https://nadp.slh.wisc.edu/pubs/brochures/). This handbook defines the roles and responsibilities of the Executive Committee, the Program Office, and all committees and subcommittees. Each role is briefly summarized in the following sections.

The NADP Program Office (PO), located at the Wisconsin State Laboratory of Hygiene (WSLH) at the UW-Madison, is responsible for promoting long-term NADP operations that comply with the operational procedures and quality-assurance standards set by the Executive Committee (EC), with guidance from its subcommittees. The PO manages day-to-day network operations. The PO responsibilities include:

1. Securing site support, chemical analytical, and data validation services for NADP measurement programs.
2. Ensuring measurement programs produce consistent quality-assured data.
3. Managing the NADP databases and website.
4. Publishing annual map summaries, data reports and other miscellaneous documents.
5. Providing support for committee and subcommittee meetings.
6. Coordinating any special studies.

The NADP Coordinator is the PO Director and works in parallel with the principal investigator of the cooperative agreements between NADP sponsors and the UW-Madison. At least three times per year, the Coordinator reports to the EC on the status and progress of PO and NADP activities.

Budgeting is on a federal fiscal year basis. The Coordinator reports on the fiscal status of the project to the Budget Advisory Committee (BAC), which is responsible for financial planning. The BAC reviews the Coordinator's report and the Coordinator's income and expenditure plans for the upcoming fiscal year. The BAC makes its budget recommendations to the EC, which has budget approval authority. BAC membership consists of elected and ex-officio members and includes the USDA-NIFA representative. The WSLH develops an annual budget that is reviewed and approved by the WSLH Board of Directors, applying a high degree of oversight on the program. As part of the review, the NADP PO develops a balanced budget based on projected income and expenditures and a detailed cost analysis. This approved budget is then presented to the BAC. The budget is continually reviewed by PO and laboratory mangers to ensure operations remain within the approved budget.

The Executive Committee (EC) is responsible for making policy decisions, budgetary decisions and ensuring program continuity and balance for NRSP-3. It provides technical and administrative guidance to the PO. The EC receives input and recommendations from the BAC on budgetary matters and the Quality Assurance Advisory Group on quality assurance matters. It receives input and recommendations from two standing technical subcommittees:

- The Network Operations Subcommittee (NOS), which oversees field-siting criteria and laboratory and sample collection protocols, and evaluates equipment and recordkeeping methods.
- The Education Outreach Subcommittee (EOS), which provides input on data user needs, and develops educational materials and programs or products to promote and increase participation.

The EC acts on recommendations and sets program policies and procedures. EC membership consists of four elected officers, the elected chairs of each of the technical subcommittee, the BAC co-chair, and a SAES representative, all of whom have voting privileges. Membership also includes ex-officio non-voting members, such as the SAES Regional Administrative Advisors, the NIFA program manager and the science committees. Membership in NADP is open and members may participate on any subcommittee or ad hoc group. Summaries of EC minutes, technical subcommittees, and science committees are provided on the web (https://nadp.slh.wisc.edu/committees/).

The EC continues to look for ways to engage new participation in its technical subcommittees, science committees, and annual meetings. In recent years, EC has added several science committees, who focus on scientific topics (critical loads (CLAD), total deposition (TDEP), mercury (MELD), aeroallergens (AMSC), urban monitoring (CitiDep)). Over the years, the focus has primarily been sulfur and nitrogen (see https://nadp.slh.wisc.edu/committees/tdep/), and is a good example of how more information (dry deposition estimates) of S and N, leverages for the benefit of agricultural researchers.

Linking multiple funding sources

The NRSP-3 project has had multiple sources of funding, since the beginning of its operation, and at least since the 1980s. Currently, the NRSP-3 is directly funded by approximately 100 agencies and groups, and funding is ~ $3 million per year. Included in these agencies is the SAES (1.6% of total budget), seven federal agencies (~56%), approximately 30 state agencies (~35%), and miscellaneous universities, local, and tribal government agencies, environmental institutes, private companies and other research organizations (~5%). In FY23, there are 103 organizations that cooperatively fund the NRSP-3. All this money is leveraged from the original decision of the SAES station research idea, multiple long-term commitment of all organizations, and the designation of a national research support project. The key our success and longevity is truly the NRSP designation.

The base funding provided by the OTT MRF funding is extremely important to this project. Beyond the base funding for SAES stations (used to pay some of the management fees), this funding confers the national research support designation. This NRSP designation allows for direct support by the USDA-NIFA. NIFA then allows for federal and state agencies to cooperate with it in the project, which is the key to our multi-funder set up and long-term success.

There are no plans to change our multidisciplinary funding mechanism, and our commitment to allow all organizations to join with us in future funding.

Contributions by SAES

As mentioned previously, the SAESs operate, and have operated our longest operating monitoring stations with the NTN. Of our current 260 NTN sites, 54 of these are either sponsored or operated by SAESs, and located at land-grant universities (see a new interactive map here https://www.google.com/maps/d/u/0/viewer?mid=1-1YiEFtbqAjIg_Pqf_TS7jZ2vyyXPyU&ll=40.105997047819784%2C-83.33217015608807&z=5). These agricultural sites are located in all four SAES regions, with 41 of 54 sites having a 40+ year operating records.

Along with basic financial support, it is worth noting that these SAES sites provide operators and, in almost all cases, pay the salaries of these operators. They provide electricity and site locations, weekly maintenance of the samplers, mailing services, and management (there is an operator and a supervisor usually located at the SAES.

Agricultural research scientists use our data every year, and these research publications are specifically highlighted annually in our NRSP reporting with the SAES and USDA systems (NMISS and REEport). Additionally, the SAES Administrative Advisors have been long-term supporters and active members of the management of the program. Since about 2007, Dr. Buhler has been a very active member of our meetings (Spring, Budget, Fall). Dr. Payne has been active, particularly during our move (2017/2018) from the University of Illinois to the University of Wisconsin Madison. Drs. White and Xia are relatively new but have already started to participate (midterm review). Dr. G. Hopper/Mississippi State was a particularly good advisor, but he has since retired.

The long-term SAES Community Representative (Dr. Richard Grant/Purdue University) has been an active member of the NRSP-3 for many years, and has been present at almost all meetings and been an officer of the EC twice.

Additionally, we have the support of the SAES here at UW-Madison. I understand they were active and agreeable to the project move from the University of Illinois, supportive of our sites in the SAES system and state, and supportive of the administrative functions (financial) with the OTT funds. We have a good working relationship with the Soils and Forage Analysis Laboratory of the SAES system at UW Madison.

A summary for capacity and modest requested support for the NRSP-3, is as follows:

- NRSP-3 continues to support nationally important areas of research, addressing multiple Grand Challenges, and other areas of important research.
- Each year, numerous agricultural research journal articles are listed, as a specific and concrete example of the SAES mission for national research support projects.
- We provide a monitoring network useful to all agricultural regions, many SAES sites, and open to all agricultural research establishments.
- We have highly leveraged SAES funding ($50,000) to $3.0 million per year through its 100 direct support collaborators.
- We make basic measurements that can be used in a myriad of research areas and have a 40+ year record of consistent and valid monitoring.
- Given our active and widespread availability of people and monitoring ability, we have the capacity to grow to meet any current need or future unseen need, with proposals made by all agricultural scientists.

Project Budget: NRSP-3 provides the authority and framework for combining the resources of many diverse sponsors in support of NRSP-3. Project support is divided into monies administered by the UW-Madison Research and Sponsored Programs (RSP) and the monies and in-kind support for operating NADP site subscribers. Cooperative funds administered by RSP provide the resources for the PO to perform duties and obligations required to satisfy the six responsibilities listed above. Subscriber support site operations including cost of sample collection, transportation and electricity to run the site, sample shipping, and land access and office space. Support for site operations is not administered by WSLH but is provided through an agreement described in the “NADP Shared Services and Responsibilities” document.

Three funding streams provide support for the PO: (1) SAES off-the-top monies, (2) a cooperative agreement between the USDA-NIFA and UW-Madison RSP, and (3) agreements between individual SAES, universities, government agencies, or non-governmental organizations and the WSLH. The USDA-NIFA/ UW-Madison RSP cooperative agreement combines the support of six federal agencies (BLM, NOAA, NPS, USDA-Forest Service, USGS, and ARS), along with USDA, each having an interagency agreement with the USDA-NIFA. Each individual (type 3) agreement funds one or more sites.

Hatch funds provide off-the-top support and the land-grant university support of SAES sites. Since these funds can pay only direct program costs and under the NRSP-3 are combined with funds from other sources, all PO support, no matter the source, pays only direct program costs. Indeed, the USDA-NIFA/UI cooperative agreement stipulates that monies be used only for direct costs and not for facilities and services. Total FY22 support from these three funding streams was $2.91 million. From FY19 to FY24, off-the-top support remained constant at $50,000. Therefore, over the years, SAES funds have been highly leveraged into an internationally successful NRSP.

NRSP-3 off-the-top monies provide partial support of the Program Coordinator. Since this position spearheads day-to-day outreach to new stakeholders and development of innovative data products that support new research interests, we propose a level NRSP-3 budget of $50,000 per year for the FY24-FY28 renewal period.

The NRSP-3 funding model has enabled project growth and diversification of funding sources (see previous section). The NTN is currently at ~260 sites (very stable over the last 15 years). For the network to maintain its size and potentially grow the program, it must contain costs and gain efficiencies in network operations. All funding support leads to reduce per site fees, thus encouraging additional involvement in NADP. With the addition of the AMoN ammonia network, site numbers have increased rapidly to approximately 100 sites, including three sites operated by SAES scientists (AR, CO). Many of the sites are federal sites, with support from US EPA and the National Park Service, again showing leveraging of SAES support to other agencies with support SAES national priorities.

With the addition of the MDN (mercury deposition) in 1996, the number of individual (type 3) agreements has risen to current 85 sites. MDN support comes largely from state, local, and tribal government agencies in states confronting a growing number of health advisories because of mercury-contaminated fish. PO outreach efforts have been successful in enlisting new MDN support from these agencies. MDN is currently at 85 sites, most in the U.S., several in Canada (six sites), and within Tribal Nations (22 sites). This network effort supports the Grand Challenge 1, 4, and 5 (food sources, although not always agriculturally derived).

The NRSP-3 committees and PO continue to look for ways the project can serve regional and national needs. Partnering with USDA-ARS to use NADP samples for detecting ASR spores in precipitation was a very good use of the networks in the past. Initiating the AMON has demonstrated the viability of cost-efficient passive sampling methods for measuring ambient ammonia and is responding to the national need to better understand ammonia sources, atmospheric cycling, and deposition. This is a good agricultural use of the networks. This network shows a strong potential for future growth. Several other potential uses of the networks and agriculture have been identified in other section of this report.

These and other efforts remain true to the vision that NRSP-3/NADP will remain one of the nation's premier research support projects, serving science and education, and supporting informed decisions on air quality issues.

The requested project budgets and specific budget narrative are in the appendix of this report.

Integration

Academic Programs: Data and information on the NADP website have become an important resource for educators at virtually every level. Users indicate that approaching 50% access on the site for educational purposes and the balance for research from academic institutions, with significant growth since the early 2000s (38% education). In 2017 (the most recent assessment, UI), total data downloads were identified as follows: 40% from federal and state agencies, 36% from universities, 16% from K-to-12 schools, and 6% from other individuals or organizations. We expect that these percentages are about the same, given their consistency over the years. These traditional tracking values have not been available at UW Madison. However, our new effort in the next 12 months (google analytics, mentioned previously) should give us a deeper insight into this type of tracking.

NADP data have been used for approximately 10-15 theses/dissertations each year. Over the last 10 years, authors have used NADP data, figures, and maps in undergraduate textbooks in biology, chemistry, environmental sciences, and related areas (54, 55). There are even used occasionally undergraduate honors theses (51). The NADP willingly supplies high quality graphics and data free of charge for these efforts. Secondary-level students continue to access on-line brochures, data and maps for use in science fair projects and classroom exercises.

NADP staff has been involved in extension work with Native American organizations concerning primarily mercury, motivated by the high tribal levels of fish consumption. NADP continues to contribute to the Institute of Tribal Environmental Professionals, National Tribal Air Association, and Tribal Air Monitoring Support Center. Additionally, over the last several years, NRSP-3 has worked within a project with U.S. EPA to further tribal monitoring within their own lands, including further NADP monitoring. Currently, the NRSP-3 cooperates with 22 separate Native American tribes/sites who operate at least one network site in one network, while several run multiple networks.

Past and Ongoing Partnerships:

- The NADP partnership with the ARS Cereal Disease Laboratory at the University of Minnesota to quantify SBR in precipitation samples continued through 2011. This project was previously described in the National Relevance section.
- During 2010 to 2012, the NADP has adopted the PRISM (Parameter-elevation Regressions on Independent Slopes Model) method for developing deposition map products. PRISM data sets, based at Oregon State University, are recognized as being of very high-quality and are supported by the USDA Natural Resources Conservation Service, USDA Forest Service, and the NOAA Office of Global Programs.

Current Partnerships:

- The NRSP-3 collaborated with numerous external monitoring and research organizations including a partnership with the 2015 Acid Rain conference (New York State), and most recently with the 2022 Acid Rain conference, held is Niigata Japan. This meeting was in cooperation with the EANet Program (NRSP-3 like in Asia), and the Japan Ministry of Environment.

- The NRSP-3 is working directly on QA intercomparisons with the National Ecological Observatory Network (NEON) on improving mercury deposition measurements for both networks and comparability between the networks. NEON representatives have recently attended several NADP fall meetings.

- The AMON and AMNet were developed at the request of stakeholders to address the needs of the agricultural research community. In both cases, these newer networks have brought in new site and funding partners, and new researchers. AMON is of particular interest to SAES scientists (discussed elsewhere in this report).

- Cooperation with Mexico: The NRSP-3 is working directly with Dr. Rodolfo Sosa/National Autonomous University of Mexico (Mexico City), to help the Country of Mexico develop a similar NTN-like network for Mexico. The idea is currently at the proposal stage with much work left to do. But our goal is to help get the network operating on a status equivalent to NTN, making intercomparison of data directly possible. In the last two semesters, two graduate students have come to the U.S. to study our methods, which seem to have been valuable. More will be reported here in later annual reports.

- Other cooperative projects have been described earlier, including the new Aeroallergens subcommittee and cooperation with health professionals, the Total N and P sampling, working with the National Park Service, and SAES scientist Dr. J. Collett at Colorado State University, etc.

Support Nationwide Research: NADP data users are in every state and data is actively downloaded by international researchers. The NADP is in the majority of U.S. states and in Canada, Puerto Rico, and the Virgin Islands, and we collaborate with nations including Mexico, Japan, China, South Korea, and Taiwan. The AMON has 100 sites in 39 states and Canada (including all four SAES regions), with preliminary gaseous ammonia measurements extending back to 2007 and official network measurements beginning in 2010. The number of active data users and monitoring sites provide indications of the breadth of support and continued interest in NRSP-3, and recognition that NADP is responsive to emerging needs of researchers and policymakers. The breadth of reports and journal articles using or citing NADP data demonstrates the nationwide, indeed international, use of NADP data.

Outreach, Communications and Assessment

Audience: The NRSP-3 mission is to provide quality-assured data and information on atmospheric deposition for use by scientists, educators, students, policymakers, and the public. **The NRSP-3/NADP has effectively supported outreach and routinely assesses the impact of these activities through quantifiable metrics.**

The NADP website provides on-line access to virtually all project data and information, including educational and informational brochures. All data from all networks is freely available to all interested users through the website (https://nadp.slh.wisc.edu/). This includes the 500,000+ samples for precipitation chemistry and wet deposition collected thus far over all regions of the U.S. and now Canada.

Download web statistics have been presented previously. User statistics show the continual growth in the number of registered users and data downloads, two indicators of the importance and relevance of the data.

In its role of assessing project performance, the NRSP-3 Executive Committee charged the PO with updating the website to improve the organizational layout, facilitate data and map accessibility, enhance communications, and modernize the “look and feel”. NADP has received beneficial feedback through its EOS as to best structure the materials to meet the needs of stakeholders. The second webpage update was completed in early 2023 and available. The website includes sections featuring:

- Education, with new materials for classrooms at the 4^{th} to 6^{th} grade and senior high level.

- News section, where NADP can highlight new happenings with the network, and all current subjects get added to the website quickly.

- Committees section, where mission statements and topics of discussion, minutes, and related materials are located.

- Publications section, including all NADP standard operating procedures, minutes, and presentations from meetings, etc.).

- Operators section, which is new in the last year is a section specifically for all site operators, including standard operating procedures, tools for uploading field data, training videos (new to the project), and a section for starting new sites.

Engagement of Stakeholders: Stakeholders are involved in committee and subcommittee activities, and twice yearly meetings as previously described. In addition, members participate in triennial laboratory and quality management reviews, where they provide recommendations for improvement. Committees and subcommittees identify emerging scientific needs and interests, where all stakeholders are welcome. For example, the AMoN, AMNet, and the new Aeroallergens subcommittees originated with committee discussions. As mentioned in “Management, Budget, and Business Plan,” the committees continually seek increase participation from land-grant university scientists, especially at annual technical meetings.

NADP actively supports engagement with stakeholders, for example at the 2019 Fall Science Symposium and Meeting, NADP through direction of its federal partners is hosted a NADP TDep Workshop "Connecting Stakeholder and Science Perspectives to Better Understand the Linkages Between Agriculture and Reactive Nitrogen Deposition". These special meeting workshops have been held in the past, including one recently on agricultural ammonium. For Spring 2024 (April 29), the TDEP subcommittee is planning for a workshop. Details will be available online with the meeting schedule.

Measuring Accomplishments: Methods to measure program outputs, accomplishments, and impacts have been described in previous sections of the proposal and include:

1. An annual request to all program participants to send a list of accomplishments and publications utilizing NADP data to the PO.
2. Routine searches of scholarly repositories, journal articles, and professional reports.
3. Compilations of web user statistics.
4. Identification of NADP data use in policy-related documents and websites, e.g., NAPAP reports, NRC reviews, government agency reports and websites.
5. Participation in NADP meetings.
6. Routine program reviews.

Many of these have been discussed in other parts of this proposal.

Communication Pieces: The NADP’s principal data product is its annual map summary report, which provides a summary of annual highlights and map products. This summary is distributed at scientific meetings and is mailed to all program participants. This year (2023), a new feature is a digital document meant to be read online in a “reading format” (see https://heyzine.com/flip-book/796fbdb6dc.html). This is designed to make it more available to younger scientists who, effectively use electronic documents. Additional publications are available on the NADP website and in print form:

1. ***Welcome to NADP***, which describes the program to “newcomers”, encourages their involvement, and is regularly updated with upcoming meeting dates.
2. ***Nitrogen From the Atmosphere****, which is a redesign and rewrite of* ***Nitrogen in the Nation’s Rain*** (early 2000s document), with a focus on the gaseous constituents, how nitrogen actually gets into precipitation, and an additional focus on dry deposition of nitrogen along with wet deposition;
3. ***Critical Loads: Evaluating the Effects of Airborne Pollutants on Terrestrial and Aquatic Ecosystems,*** where this brochure outlines the function of NADP’s Critical Loads Scientific Subcommittee, outlining their products (mapping of critical loads for forests primarily for N, etc.);
4. An updated ***Ammonia Monitoring Network (AMoN) Fact Sheet*****,** which describes issues related to gaseous ammonia, and provides an overview of methods and measurements in the AMoN; and
5. ***NADP’s Governance Handbook***, providing the structure and operation of NADP’s officers, committees, and organization (continually updated), providing a primer for stakeholders, students, and new scientists of the structure and operation of NADP (provided at meetings). This document is updated regularly.

Distribution of Results: As described in previous sections of this proposal, NADP data are distributed primarily via the NADP website, which offers easy-to-use on-line retrieval of data in multiple formats. During 2022, NADP estimated ~20,000 comma-delineated data sets were downloaded, including 14,000 from the NTN database.

In addition, during the next 12 months, with support from UW-Madison computing, NADP would like to add Google Analytics (or similar) to our website. This software is sold as marketing software, but we will use it to give a much deeper insight into who is visiting our website, provide a better understanding of what users are looking for, and very specific counts of what webpages are being read, what is being downloaded, etc. This type of information is very valuable in reporting (as with this report), and for the Education Subcommittee (EOS) to fulfill its goals.

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Outreach Plan

Audience: The NRSP-3 mission is to provide quality-assured data and information on atmospheric deposition for use by scientists, educators, students, policymakers, and the public. **The NRSP-3/NADP has effectively supported outreach and routinely assesses the impact of these activities through quantifiable metrics.**

The NADP website provides on-line access to virtually all project data and information, including educational and informational brochures. All data from all networks is freely available to all interested users through the website (https://nadp.slh.wisc.edu/). This includes the 500,000+ samples for precipitation chemistry and wet deposition collected thus far over all regions of the U.S. and now Canada.

Download web statistics have been presented previously. User statistics show the continual growth in the number of registered users and data downloads, two indicators of the importance and relevance of the data.

In its role of assessing project performance, the NRSP-3 Executive Committee charged the PO with updating the website to improve the organizational layout, facilitate data and map accessibility, enhance communications, and modernize the “look and feel”. NADP has received beneficial feedback through its EOS as to best structure the materials to meet the needs of stakeholders. The second webpage update was completed in early 2023 and available. The website includes sections featuring:

- Education, with new materials for classrooms at the 4^{th} to 6^{th} grade and senior high level.
- News section, where NADP can highlight new happenings with the network, and all current subjects get added to the website quickly.
- Committees section, where mission statements and topics of discussion, minutes, and related materials are located.
- Publications section, including all NADP standard operating procedures, minutes, and presentations from meetings, etc.).
- Operators section, which is new in the last year is a section specifically for all site operators, including standard operating procedures, tools for uploading field data, training videos (new to the project), and a section for starting new sites.

Engagement of Stakeholders: Stakeholders are involved in committee and subcommittee activities, and twice yearly meetings as previously described. In addition, members participate in triennial laboratory and quality management reviews, where they provide recommendations for improvement. Committees and subcommittees identify emerging scientific needs and interests, where all stakeholders are welcome. For example, the AMoN, AMNet, and the new Aeroallergens subcommittees originated with committee discussions. As mentioned in “Management, Budget, and Business Plan,” the committees continually seek increase participation from land-grant university scientists, especially at annual technical meetings.

NADP actively supports engagement with stakeholders, for example at the 2019 Fall Science Symposium and Meeting, NADP through direction of its federal partners is hosted a NADP TDep Workshop "Connecting Stakeholder and Science Perspectives to Better Understand the Linkages Between Agriculture and Reactive Nitrogen Deposition". These special meeting workshops have been held in the past, including one recently on agricultural ammonium. For Spring 2024 (April 29), the TDEP subcommittee is planning for a workshop. Details will be available online with the meeting schedule.

Measuring Accomplishments: Methods to measure program outputs, accomplishments, and impacts have been described in previous sections of the proposal and include:

1. An annual request to all program participants to send a list of accomplishments and publications utilizing NADP data to the PO.
2. Routine searches of scholarly repositories, journal articles, and professional reports.
3. Compilations of web user statistics.
4. Identification of NADP data use in policy-related documents and websites, e.g., NAPAP reports, NRC reviews, government agency reports and websites.
5. Participation in NADP meetings.
6. Routine program reviews.

Many of these have been discussed in other parts of this proposal.

Communication Pieces: The NADP’s principal data product is its annual map summary report, which provides a summary of annual highlights and map products. This summary is distributed at scientific meetings and is mailed to all program participants. This year (2023), a new feature is a digital document meant to be read online in a “reading format” (see https://heyzine.com/flip-book/796fbdb6dc.html). This is designed to make it more available to younger scientists who, effectively use electronic documents. Additional publications are available on the NADP website and in print form:

1. ***Welcome to NADP***, which describes the program to “newcomers”, encourages their involvement, and is regularly updated with upcoming meeting dates.

2. ***Nitrogen From the Atmosphere****, which is a redesign and rewrite of* ***Nitrogen in the Nation’s Rain*** (early 2000s document), with a focus on the gaseous constituents, how nitrogen actually gets into precipitation, and an additional focus on dry deposition of nitrogen along with wet deposition;

3. ***Critical Loads: Evaluating the Effects of Airborne Pollutants on Terrestrial and Aquatic Ecosystems,*** where this brochure outlines the function of NADP’s Critical Loads Scientific Subcommittee, outlining their products (mapping of critical loads for forests primarily for N, etc.);

4. An updated ***Ammonia Monitoring Network (AMoN) Fact Sheet*****,** which describes issues related to gaseous ammonia, and provides an overview of methods and measurements in the AMoN; and

5. ***NADP’s Governance Handbook***, providing the structure and operation of NADP’s officers, committees, and organization (continually updated), providing a primer for stakeholders, students, and new scientists of the structure and operation of NADP (provided at meetings). This document is updated regularly.

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Organization/Governance

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Land Grant Participating States/Institutions

NY,CA,UT,WI,CO,MN

Non Land Grant Participating States/Institutions

Participation

Participant	Is Head	Station	Objective	Research						Extension	
				KA	SOI	FOS	SY	PY	TY	FTE	KA

Combined Participation

Combination of KA, SOI and FOS	Total SY	Total PY	Total TY
Grand Total:	**2.60**	**0.30**	**1.10**
112	0.05	0	0.1
141	0.05	0	0.1
141	0.2	0	0
141	0.1	0	0
133	0.5	0	0
133	0.5	0	0
112	0.03	0.3	0
133	0.03	0.3	0
141	0.03	0.3	0
141	0.1	0	0
102	1	0	1

Program/KA	Total FTE
Grand FTE Total:	**0**
0	0
0	0
0	0
0	0
0	0
0	0

Budgets

MRF Funding 2024

Description	Dollars	FTE
Salaries	37600.00	1.00
Fringe Benefits	12400.00	0.00
Wages	0.00	0.00
Travel	0.00	0.00
Supplies	0.00	0.00
Maintenance	0.00	0.00
Equipment / Capital Improvement	0.00	0.00
Other	0.00	0.00
Totals	**50000**	**1**

Comments

MRF Funding 2025

Description	Dollars	FTE
Salaries	37600.00	1.00
Fringe Benefits	12400.00	0.00
Wages	0.00	0.00
Travel	0.00	0.00
Supplies	0.00	0.00
Maintenance	0.00	0.00
Equipment / Capital Improvement	0.00	0.00
Other	0.00	0.00
Totals	**50000**	**1**

Comments

MRF Funding 2026

Description	Dollars	FTE
Salaries	37600.00	1.00
Fringe Benefits	12400.00	0.00
Wages	0.00	0.00
Travel	0.00	0.00
Supplies	0.00	0.00
Maintenance	0.00	0.00
Equipment / Capital Improvement	0.00	0.00
Other	0.00	0.00
Totals	**50000**	**1**

Comments

MRF Funding 2027

Description	Dollars	FTE
Salaries	37600.00	1.00
Fringe Benefits	12400.00	0.00
Wages	0.00	0.00
Travel	0.00	0.00
Supplies	0.00	0.00
Maintenance	0.00	0.00
Equipment / Capital Improvement	0.00	0.00
Other	0.00	0.00
Totals	**50000**	**1**

Comments

MRF Funding 2028

Description	Dollars	FTE
Salaries	37600.00	1.00
Fringe Benefits	12400.00	0.00
Wages	0.00	0.00
Travel	0.00	0.00
Supplies	0.00	0.00
Maintenance	0.00	0.00
Equipment / Capital Improvement	0.00	0.00
Other	0.00	0.00
Totals	**50000**	**1**

Comments

Budgets

MRF Funding 2024

Description	Dollars	FTE
Salaries	37600.00	1.00
Fringe Benefits	12400.00	0.00
Wages	0.00	0.00
Travel	0.00	0.00
Supplies	0.00	0.00
Maintenance	0.00	0.00
Equipment / Capital Improvement	0.00	0.00
Other	0.00	0.00
Totals	**50000**	**1**

Comments

MRF Funding 2025

Description	Dollars	FTE
Salaries	37600.00	1.00
Fringe Benefits	12400.00	0.00
Wages	0.00	0.00
Travel	0.00	0.00
Supplies	0.00	0.00
Maintenance	0.00	0.00
Equipment / Capital Improvement	0.00	0.00
Other	0.00	0.00
Totals	**50000**	**1**

Comments

MRF Funding 2026

Description	Dollars	FTE
Salaries	37600.00	1.00
Fringe Benefits	12400.00	0.00
Wages	0.00	0.00
Travel	0.00	0.00
Supplies	0.00	0.00
Maintenance	0.00	0.00
Equipment / Capital Improvement	0.00	0.00
Other	0.00	0.00
Totals	**50000**	**1**

Comments

MRF Funding 2027

Description	Dollars	FTE
Salaries	37600.00	1.00
Fringe Benefits	12400.00	0.00
Wages	0.00	0.00
Travel	0.00	0.00
Supplies	0.00	0.00
Maintenance	0.00	0.00
Equipment / Capital Improvement	0.00	0.00
Other	0.00	0.00
Totals	**50000**	**1**

Comments

MRF Funding 2028

Description	Dollars	FTE
Salaries	37600.00	1.00
Fringe Benefits	12400.00	0.00
Wages	0.00	0.00
Travel	0.00	0.00
Supplies	0.00	0.00
Maintenance	0.00	0.00
Equipment / Capital Improvement	0.00	0.00
Other	0.00	0.00
Totals	**50000**	**1**

Comments

Appendix F: Budget

Project Title: NRSP003 - The National Atmospheric Deposition Program (NADP)

Requested Duration: October 1, 2024 to September 30, 2028 (FY24-FY28)

Budget & Narrative

In support of the NRSP-3 application, we present the following budget and narrative description.

The MRF funding will be used for salary support for one person at the Program Office of the National Atmospheric Deposition Program. This support for the Program Coordinator will go towards the management of the project, and support the positions most responsible for carrying out the outreach and communication mission of the NRSP. This funding will provide approximately one-half of the salary and benefits for this employee. The FY24 salary figure represents salary for the Program Coordinator, based on current FY23 salary. Other non-salary funding is not being requested.

The "Other Sources" table also contains a few assumptions and requires further explanation. These values include all funding categories listed (industry, federal agencies, grants/contracts, and SAESs). Therefore, this table represents the total project budget plus the SAES funding (approximately 1.6% of the total budget). This budget begins with the approved 2020 budget value. With these assumptions, annual values are estimated for the next five funding years.

Additional categories were added to this table to demonstrate itemized costs important to this project. The total wages (fringe plus salary) are reported are the sum of the Salary and Fringe lines. The total FTE represent all projected PO and laboratory personnel required to successfully operate the program. Supplies and services include all contractual services and the supplies for PO and laboratories including printing and laboratory supplies to operate during the project period. Maintenance and repair includes equipment upkeep (maintenance contracts and repairs), depreciation on equipment, building changes and upkeep and the like. Communication include the cost of office communication including operation of the site liaison 800 number, and some printing. Travel and training includes costs associated with the spring and fall meetings as well as cost for outreach such as at national conferences. Rent and overhead cover the small cost of building rent, and overhead associated with WSLH support including NADP subscriber billing (financial), purchasing services, human resources services, and information technology services (computing, web).

NRSP-3, The National Atmospheric Deposition Program (NADP) - A Long-term Monitoring Program in Support of Research on the Effects of Atmospheric Chemical Deposition										
DESCRIPTION	**Proposed FY20**		**Proposed FY21**		**Proposed FY22**		**Proposed FY23**		**Proposed FY24**	
	Dollars	**FTE**	**Dollars**	**FTE**	**Dollars**	**FTE**	**Dollars**	**FTE**	**Dollars**	**FTE**
Salaries	37,600	0.6	37,600	0.6	37,600	0.6	37,600	0.6	37,600	0.6
Fringe Benefits	12,400		12,400		12,400		12,400		12,400	
Total Wages (Salary and Fringe)	50,000		50,000		50,000		50,000		50,000	
Supplies & Services	0		0		0		0		0	
Maint. & Repairs	0		0		0		0		0	
Communication	0		0		0		0		0	
Travel & Training	0		0		0		0		0	
Rent & Capital Equip. Dep.										
TOTAL	50,000	0.6	50,000	0.6	50,000	0.6	50,000	0.6	50,000	0.6
OTHER SOURCES OF FUNDING **Other: EPA, USGS, ARS, USFS, US Park Service, BLM, NOAA, States, Tribes, Canada, Industry, NGOs, etc.**										
DESCRIPTION	**Proposed FY24**		**Proposed FY25**		**Proposed FY26**		**Proposed FY27**		**Proposed FY28**	
	Dollars	**FTE**	**Dollars**	**FTE**	**Dollars**	**FTE**	**Dollars**	**FTE**	**Dollars**	**FTE**
Salaries	1,400,000	25.3	1,400,000	25.3	1,400,000	25.3	1,400,000	25.3	1,400,000	25.3
Fringe Benefits	486,000		486,000		486,000		486,000		486,000	
Total Wages (Salary and Fringe)	1,886,000		1,886,000		1,886,000		1,886,000		1,886,000	
Supplies & Services	426,000		426,000		426,000		426,000		426,000	
Maint. & Repairs	322,000		322,000		322,000		322,000		322,000	
Communication	5,000		5,000		5,000		5,000		5,000	
Travel & Training	47,000		47,000		47,000		47,000		47,000	
Rent, Overhead & Capital Equip. Dep.	173,000		173,000		173,000		173,000		173,000	
TOTAL	2,859,000	25.3	2,859,000	25.3	2,859,000	25.3	2,859,000	25.3	2,859,000	25.3

NRSP Review (Submitted)

Project: The National Atmospheric Deposition Program (NADP)

Dates Covered 10/01/2024 - 09/30/2029

The following statement defines the mission of the National Research Support Projects (NRSP's):

NRSP Mission: National Research Support Projects (NRSPs) focus on the development of enabling and critical technologies (e.g., databases, cyberinfrastructure, on-line toolkits, reagents), support activities (e.g., collect, assemble, store, and distribute materials, data, resources or information) or the sharing of facilities (e.g., analytical equipment, lab, field) needed to accomplish high priority research.

Based on this mission, please rate the proposed NRSP using the following criteria.

	Satisfactory	Unsatisfactory
Mission:		
Consistency with the NRSP mission	◉	○
Relevance:		
Addresses and supports a high priority national issue	◉	○
Demonstrates clear and tangible benefits to the scientific community as a whole	◉	○
Clearly identified sponsoring beneficiary stakeholders	◉	○
Stakeholder involvement in project development, project activities, review, and/or management plans	◉	○
Technical Merit:		
Overall technical merit (sound scientific approach, achievable objectives, review, and/or management plans	◉	○
Potential for significant outputs (products) and outcomes with impacts	◉	○
Implementation Plan:		
Benchmarks for success clearly identified	◉	○
Management structure that adequately coordinates efforts of multiple participants	◉	○
Well-developed business plan that captures multiple sources of funding and leverages OTT MRF	◉	○
Funding plan that develops alternative funding sources to reduce OTT MRF in future years	◉	○
Efforts integrated with Extension, academic, or international programs	◉	○
Outreach, communications and assessment plan that communicates the program goals, accomplishments, and outcomes, and impacts	◉	○

Comments (Please add general and specific comments on strengths and weaknesses of the proposal, including specific revisions that would improve the proposal):

Strengths

Very well written proposal. Excellent description of previous project impacts and how the work addresses multiple grand challenges of the Science Roadmap for Food and Agriculture. The proposal clearly articulates the scientific merit and impact of the National Atmospheric Deposition Program, as well as the needs for continuing this program. The implementation plan is clearly outlined with the objectives for the next 5 years logical and clear. The projected outcomes are well described, and the budget is appropriate.

Overall Recommendation: Approve xxxx Approve with revision Disapprove

Weaknesses

Overall Recommendation: Approve

Report a Bug

Cancel (https://nimss.org/review/my_reviews)

Return to Draft Status

Report a Bug

NRSP_TEMP3 AA Combined Review comments

Strengths

Very well written proposal. Excellent description of previous project impacts and how the work addresses multiple grand challenges of the Science Roadmap for Food and Agriculture. The proposal clearly articulates the scientific merit and impact of the National Atmospheric Deposition Program, as well as the needs for continuing this program. The implementation plan is clearly outlined with the objectives for the next 5 years logical and clear. The projected outcomes are well described, and the budget is appropriate.

Overall Recommendation: Approve

Weaknesses

A few things for consideration as the final proposal is prepared:

1. Section A needs a better description of what data were collected in the past, what data are currently collected, what data will continue to be collected, and what new data collection initiatives will be proposed and implemented. The first 3 paragraphs of Section A were a bit confusing.

2. The statement on page 8 of the proposal regarding interactions with other groups seems passive and did not provide any indication if HADP has made any effort in communicating with other groups. If dialogues with the “other NRSPs” have not happened in the past, we suggest you make this a top priority when starting the next phase of the project. The AA’s can assist with linkages.

3. The proposal would benefit from a more complete description in the plan for Objective 1 on the chemical and biological characterization.

4. One reviewer provided some minor comments directly on the proposal. Those suggestions were shared with the PI.

NRSP Review (Submitted)

Project: The National Atmospheric Deposition Program (NADP)

Dates Covered 10/01/2024 - 09/30/2029

The following statement defines the mission of the National Research Support Projects (NRSP's):

NRSP Mission: National Research Support Projects (NRSPs) focus on the development of enabling and critical technologies (e.g., databases, cyberinfrastructure, on-line toolkits, reagents), support activities (e.g., collect, assemble, store, and distribute materials, data, resources or information) or the sharing of facilities (e.g., analytical equipment, lab, field) needed to accomplish high priority research.

Based on this mission, please rate the proposed NRSP using the following criteria.

	Satisfactory	Unsatisfactory
Mission:		
Consistency with the NRSP mission	◉	○
Relevance:		
Addresses and supports a high priority national issue	◉	○
Demonstrates clear and tangible benefits to the scientific community as a whole	◉	○
Clearly identified sponsoring beneficiary stakeholders	◉	○
Stakeholder involvement in project development, project activities, review, and/or management plans	◉	○
Technical Merit:		
Overall technical merit (sound scientific approach, achievable objectives, review, and/or management plans	◉	○
Potential for significant outputs (products) and outcomes with impacts	◉	○
Implementation Plan:		
Benchmarks for success clearly identified	◉	○
Management structure that adequately coordinates efforts of multiple participants	◉	○
Well-developed business plan that captures multiple sources of funding and leverages OTT MRF	◉	○
Funding plan that develops alternative funding sources to reduce OTT MRF in future years	◉	○
Efforts integrated with Extension, academic, or international programs	◉	○
Outreach, communications and assessment plan that communicates the program goals, accomplishments, and outcomes, and impacts	◉	○

Comments (Please add general and specific comments on strengths and weaknesses of the proposal, including specific revisions that would improve the proposal):

The review conducted by Catherine Collins, Environmental Engineer, US Fish and Wildlife Service, was an inline review with changes tracked of the NRSP_temp3 proposal and it included with the proposal attachments.

Overall Recommendation: Approve with Revision

Report a Bug

NRSP Proposal Format

Project Title: NRSP3: The National Atmospheric Deposition Program (NADP)

Requested Duration: 10/01/2024 to 09/30/2029

Administrative Advisors: Dr. Douglas Buhler/Michigan State Un., Dr. Jason C White/State of Connecticut, Dr. Kang Xia/Virginia Polytechnic Institute and State University, Dr. William Payne/University of Nevada Reno

NIFA Representative: Dr. Amy Ganguli, USDA-National Institute of Food and Agriculture

Statement of Issues and Justification:
Prerequisite Criteria:

A. How is the NRSP consistent with the mission? (8,000 characters)

National Research Support Project-3 (the National Atmospheric Deposition Program, or NADP provides a national ~~(~~and ~~now~~ international~~)~~ monitoring cooperative to measure the flow of air pollutants into all managed agricultural systems and all other environments over the United States and Canada. Through this cooperation, a research database of pollutant concentration measurements in precipitation and downward fluxes has been developed, which supports significant and important agricultural researchers in several specific areas (collection, assemble, storage, distribution, information, etc.). This cooperative approach directly supports the NRSP mission, by providing basic chemical measurements of sulfur, nitrogen, chloride, and other cations into agricultural systems for researchers to use. All of these compounds are or could be important in many agricultural settings, so the NRSP-3 thereby supports a wide array of agricultural research activities in any number of ~~ways, and~~ways and supports many other types of environmentally-connected research simultaneously.

NRSP-3 provides a collaborative framework for participating scientists from State Agricultural Experiment Stations (SAES); universities; federal, state, local, and tribal government agencies; national forests and laboratories; environmental institutes; private companies; and other research organizations who cooperate in sponsoring NADP measurement networks. We support the NRSP mission by providing agriculturally-related data that can be used at any and all SAES, any land-grant

university (1862, 1890, 1994), and allows for SAES/agricultural scientists to cooperate more easily with researchers from different departments, colleges, universities, and government institutions. Finally, this data is provided to researchers free of charge.

The NADP provides the only regional and national-scale data and information on the amounts, geographic distribution, and trends in chemical deposition by precipitation in North America. The NADP operates five networks which support differing research goals and areas of interest. For this proposal, the agricultural community primarily cooperates in two large ~~networks;~~networks: the National Trends Network (NTN) and the Ammonia Monitoring Network (AMoN). Specifically, the NTN provides weekly concentrations in precipitation of free acidity (H^+ as pH and concentration of this ion), specific conductance, nitrate (NO_3^-), ammonium (NH_4^+), sulfate (SO_4^{2-}), calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+), potassium (K^+), and chloride (Cl^-). The AMoN provides two-week atmospheric concentrations of ammonia gas (NH_3). These compounds are important for agricultural research and therefore, can be used in any number of research areas and projects, as is shown year in and year out in our output statistics and project results.

The NRSP-3 research database of these two networks (NTN, AMoN) now includes over 600,000 measurements of precipitation chemistry, extending from 1978 to ~~mid 2023~~mid-2023. Each of these records has an observation of each ~~previously listed~~previously listed chemical component, the amount of precipitation for the week, a valid or invalid measurement determination, and a date and time of the measurement, all for over approximately 300 monitoring locations. Finally, the 53 SAES-associated stations have the longest continuing records since most of these sites were the original NRSP-3 sites in the network. Almost all these sites have 40+ year historical records.

Distribution of NRSP-3 data is through a web-accessible database, where **all** scientists and data users have access to ~~any and all~~all data available, meaning no data or information is sequestered. It is a truly publicly available database for anyone to use (research, education, or policy, see https://nadp.slh.wisc.edu/).

The NRSP-3 has demonstrated flexibility and response to the current and future national needs of the research community for information over a broad array of scientific topics. These topics include the effects of atmospheric deposition on terrestrial and aquatic ecosystems, biogeochemical cycling, climate change, and human health. NRSP-3 data support informed decisions on air quality issues related to precipitation chemistry and atmospheric deposition. NRSP-3 also directly supports the Grand Challenges of the *Science Roadmap for Food and Agriculture* (1), and particularly Grand

Challenge 1, 2, 3 and 6, and partially 4 and 5. In general, NRSP-3 information has been invaluable in:

- Documenting the presence and removal of inorganic pollutant gases and aerosols in the atmosphere (i.e., the United States' "chemical climate");
- Documenting how atmospheric chemicals are changing in amount and relative composition over time (trends determination);
- Understanding the effects of atmospherically-deposited chemicals on agricultural crops, national and state and private forests, rangelands, surface and ground waters, estuaries, aquatic impoundments, and other natural resources;
- Documenting the flow of agricultural nitrogen, evaluating new agricultural methods to control the release of nitrogen from cultivated fields and crops into waterways and the atmosphere, tracing gaseous ammonia emissions and movement from agricultural operations, satellite-based tracking of NH_3 in the atmosphere from source to sink, and used in many other agricultural modeling efforts;
- Assessing the accelerated weathering of material and cultural resources resulting from atmospheric chemical deposition;
- Discerning pollutant sources and source distributions and their relationships to deposition (i.e., source-receptor relationships); and
- Evaluating the effectiveness of current Clean Air Act (CAA) legislation and subsequent rules promulgated under the act, and the impact of atmospheric deposition on water quality requirements set by the Clean Water Act.

B. How does this NRSP pertain as a national issue? (10,000 characters)

As stated previously, the NRSP-3 directly supports many national priorities and Grand Challenges of the *Science Roadmap for Food and Agriculture* (1), particularly for the Challenge 1, 2, 3 and 6, and partially 4 and 5. It also supports these for all SEAS regions and stations.

Use by multiple locations/regions: Since its 1977 founding as NC-141 by the SAES, NRSP-3 has offered a unique opportunity for cooperation among scientists from land grant and other universities, government agencies, and other organizations. It provides a framework for leveraging the resources of over 100 sponsoring agencies to address current and emerging national issues. Within the networks, 54 NADP sites are either sponsored or operated by SAESs, located at land-grant universities, or are run by ARS scientist. These 54 sites are located in all four SAES regions, with 41 of 54 sites having a

40+ year operating record and therefore, represent almost all of the longest-running precipitation chemistry sites in the world.

Addressing National Issues:

Over the 40+ year existence of NRSP-3, several relevant national issues have been addressed by NRSP-3's collected data.

Originally, the SAES North Central Region established NC-141 to address "Chemical Changes in Atmospheric Deposition and Effects on Agricultural and Forested Land and Surface Waters in the United States" (2). The objectives were to a) "establish an atmospheric deposition network for measuring beneficial nutrients and potentially injurious substances in precipitation and dry particulate matter" and to b) "organize and coordinate research on atmospheric deposition effects". The initial focus has been on the pH of precipitation, and principally sulfate ion (combustion of coal).

The NC-141 initiated the collection of one-week integrated wet-only deposition in 1978, and quickly had operating sites in all four SAES regions. Organizing the efforts were principally SAES scientists, federal and state agencies, and university scientists. Justified by the potential for human activities to affect atmospheric chemistry and, in turn, the nutrient status of terrestrial and aquatic systems (3-5). In 1980, a 10-year program entitled the National Acid Precipitation Assessment Program (NAPAP) was launched (6) as the National Trends Network (NTN), which ultimately merged with the existing NADP as NADP/NTN (6, 7). One review panel concluded: "The monitoring program and resultant data (i.e. NRSP-3) that is being constructed is perhaps the most significant, long-term, continuous, and comprehensive sampling and analysis program to be undertaken in the environmental sciences" (8).

SAES Directors have renewed the resulting NRSP-3 program through several iterations from 1992 through 2023, given that NRSP-3 has shown, through scientific measurement, that:

- Chronic chemical loading from atmospheric deposition can result in long-term changes,
- There is significant acidic sulfate and nitrate decrease nationwide (9),
- No evidence has shown that acidic precipitation at ambient U.S. levels is responsible for regional crop yield reductions (10),
- Ambient deposition in high-elevation eastern-U.S. forests is altering nutrient status leading to growth reduction, frost intolerance, or decline of these ecosystems (10),

- Acidic deposition is causing long-term chemical changes in soils (10),
- Atmospheric sulfate deposition results in some poorly buffered surface waters becoming more toxic (11),
- Acidic deposition increases the corrosion of metals and alloys (12).

These overarching results detail explicitly several *national issues* of concern; chemical changes to agricultural/all soils, changing precipitation concentrations over the U.S., impacts to all forests of concern to USDA-Forest Service and National Park Service, chemical changes in water quality (drinking water included), and impacts to structures (stone, metal, etc.). The NRSP-3 addresses all these national concerns directly, by providing weekly measurements of the concentration and flux of precipitation pH, chemical conductivity, and eight chemical constituents.

Here are some brief examples of how NRSP-3 functions to meet other national needs and science.

Acidic Precipitation:

- *The Clean Air Act Amendments of 1990 (CAAA-90) sought "to reduce the adverse effects of acid deposition through reductions in annual emissions of sulfur dioxide (SO_2) and nitrogen oxides (NO_x).*" The Act required monitoring and reporting the effect of these emissions reductions on deposition (13). The NTN has been used to show dramatic decreases in sulfate deposition, where several reports have shown that agricultural professionals are now needing to add S into fertilizers now, since it is no longer being deposited in rain. (14)
- NTN measures the wet deposition of both NO_3^- and NH_4^+. Many recent papers have shown that NO_3^- is now the most important pollutant driving acidification in precipitation (15), given the strong sulfur reductions. However, with precipitation remaining acidic (https://nadp.slh.wisc.edu/maps-data/ntn-gradient-maps/), researchers have now focused on total N deposition. Therefore, NADP is still measuring the main forcing mechanism of acidic precipitation. Agriculture and fertilizer use is a major source of the N compounds in precipitation.
- Li, et al. (2016) showed that atmospheric N is no longer dominated by nitrogen oxides (combustion) but by reduced N forms, with this change since the 1990s. These result used NRSP-3 data. Now, the largest contributor to N wet deposition is reduced N compounds, such as organic nitrogen and ammonia gas (NH_3). *Again, a major source of both of these categories is agricultural activity* (fertilizer, animal feeding operations, waste lagoons, etc.). ~~Therefore~~Therefore, more agricultural researchers are focusing on reduced N deposition.

Nitrogen Fertilization, Species Diversity, and Invasive Species

- Many scientists have shown the connection between N deposition and species changes in the natural environment, and to changes in the USDA-controlled national forests. N enrichment could be decreasing both species diversity and abundance of plants (16).
- Since in many agricultural situations, N is used as a fertilizer, many of our recently noted agricultural articles have used NRSP-3 data in nitrogen balance questions in agricultural research (~~e.g.~~e.g., 17). Many researchers are looking for the importance of deposition in agricultural situations and looking at how new agricultural practices will affect N flow (18).

National Issue of Air Quality

Trends in nitrogen species have not demonstrated the same consistency as sulfate wet deposition. Although NO_3^- concentrations have decreased in the Northeast since the mid-1980s, significant increases have occurred in the Great Plains and Rocky Mountain states (19-22). Increases in NH_4^+ ion over the same period have been nearly as widespread as sulfate decreases (20). These trends are illustrated in NADP year-to-year map animations (http://nadp.slh.wisc.edu/data/animaps.aspx). These ammonia trends have continued (23, 24), emphasizing the importance of agriculture participation in national-level studies with the predominant source of NH_3 originating from agricultural sources.

Continued Importance of Ammonia/Ammonium

The importance of NH_3 emissions to the atmosphere continues, particularly in the central U.S. This relationship to agricultural sources is well-documented by many agricultural scientists (~~e.g.~~e.g., 25). In response to early indications, NRSP-3 established the AMoN to measure ambient gaseous ammonia concentrations. Over the past 10 years, the AMoN has grown to a national network, measuring NH_3 at approximately 100 sites. AMoN data continue to be useful to agricultural scientists used to better understand the emission, impact and dry deposition of NH_3. The AMoN represents the first consistent, long-term regional/national measurements of gaseous NH_3, and AMoN measurements will provide a baseline for evaluating subsequent reductions.

A new research paper released this month (26) demonstrates with satellite data that atmospheric NH_3 is an international issue of great importance and focuses on the lack of gaseous measurements in the U.S. They specifically call for more NH_3 gas measurements in the rural U.S., given the rise in animal production. This article

supports continued agricultural measurement in the AMoN network, and the use of its data by agricultural scientists.

New Measurements Planned to Address Other National Needs:

- Algal Blooms hasve become a major environmental problem in recent years, andyears and have been featured in a multipleyriad of national newspress stories. Algal bloom has been associated with phosphorus addition to P-limited lakes, with P likely from the atmosphere (27). Atmospheric P measurements are needed to understand these algal blooms in these situations and the connection . This issue is connected to agriculture since itagriculture is a very large user of P and likely a large source contributer to lakes, rivers, and water impoundments (e.g., Lake Erie, for example). Many recent publications are calling for national total P measurements in the atmosphere (28). NRSP-3 is currently developing a measurement method for the measurement of Total P in precipitation as (discussed in other sections).
- Algal Blooms and Total Nitrogen. Many algal bloom situations are also limited by N and partially byin part N deposition. Recently, iIncreases in NH_4^+ wet deposition have been shown. NRSP-3 is currently developing a measurement method for the measurement of Total N in precipitation (combined with the Total P measurement). This will allow scientists determine total loading of N more accurately to algal bloom situations, and research therein. An additional issue is the contribution of Organic Nitrogen (ON), which is at least currently unmeasured, but will also be estimated with this planned Total N measurement (see below).
- Organic Nitrogen in the Atmosphere. The contribution of Organic Nitrogen (ON) is currently unmeasured will be estimated as part of Total N measurement .With the importance of atmospheric N measurement is Tthe importance of quantifying ON in the atmosphere. ON has now become important to both air quality scientists and agricultural scientists (e.g. 29). It is thought that up to 25% of atmospheric N is in the organic form and not routinely measured. NRSP-3 is developingworking on a plan now to add a total N measurement and using subtraction, estimate the ON concentration in all samples. Secondary samplers have been developed for use by any/all NTN sites that can be used to make this measurement. This method should be ready for field trials in the next few months and will be offered to all NTN sites for adoption. The sources of ON clearly include agricultural activities.

Other National Issues

- Studies have connected atmospheric N deposition to estuarine eutrophication and related low dissolved oxygen concentrations and losses of aquatic vegetation (24, 30). Other studies have reported alterations of species richness and diversity of soil

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flora (31). Increasing N deposition trends in the West have heightened concerns over the potential effects of nutrient additions in alpine and subalpine areas in the Rockies and Cascades (23).

- *Phakopsora pachyrhizi*, commonly called Asian Soybean Rust (ASR), was first reported in the continental U.S. in November 2004. ASR is an obligate fungal parasite thought to rely on a living host (e.g., legumes such as soybean) for survival (32). ASR spreads through aerial dispersal and deposition of urediniospores, which can be transported widely before being deposited by precipitation. With support from the Agricultural Research Service (ARS), NADP collected NTN samples over five years through 2010 (nadp.slh.wisc.edu/educ/asr/, 33-36). These studies demonstrate the application of this NRSP in tracking many different airborne pathogens in U.S. agricultural crops.

Specifically, to the support of other NRSPs, the NRSP-3 data is certainly available to all other NRSPs. However, it is not ~~know~~known if any of them use our data. Nonetheless, we provide data that should be useful to other NRSPs, such as P, N and S input rates that are coming in naturally to U.S. agricultural lands. One would think NRSP-3 data would be particularly important to *NRSP11: Building Collaborative Research Networks to Advance the Science of Soil Fertility: Fertilizer Recommendation Support Tool (FRST).* This model certainly would benefit in many situations from atmospheric input measurements that NADP provides.

Overall, the NRSP-3, with its structure, scientific direction, and site locations around North America can be used to make many fundamental measurements in a wide variety of ways to measure the moment of chemical or lifeforms in many new ways to support many challenges to agricultural researchers.

Rationale:

NRSP-3 directly supports the Grand Challenges of the *Science Roadmap for Food and Agriculture* (1), and specifically Grand Challenge 1, 2, 3 and 6. NRPS-3 also ~~somewhat~~ supports Challenges 4 and 5.

Grand Challenge 1 "*We must enhance the sustainability, competitiveness, and profitability of U.S. food and agricultural systems."*
The NRSP-3 directly supports to sustainability and profitability of the U.S. food and agricultural system. This support is provided by:

- The sustainably, through the monitoring of pollutants that are emitted from agricultural operations, including N pollution in general, and ammonium, ammonia and organic nitrogen (this next year). We measure these compounds in both precipitation and in the ~~atmosphere, and~~atmosphere and has detailed many research activities pursued by agricultural scientists. Pollution of the surrounding environment is not a sustainable process, and agricultural scientists are studying new methods to control these emissions. NRSP-3 can monitor for the current emissions, and current observations can be used to monitor emissions over time to determine ~~if and when~~when the issue is becoming more sustainable (fewer impacts).
- NRSP-3's role in the monitoring of N loss from animal feeding operations and waste. Impact upon the surrounding environment is not a sustainable future.
- Competitiveness and profitability, since much of this nitrogen is used as fertilizers. Less unused fertilizer goes directly to this challenge.
- The presence of Phosphorous, being heavily used by agricultural operations as fertilizers, ~~also~~ provides a role for NRSP-3 to monitor the growing amount of P in the atmosphere and in deposition, leading to research designed to reduce the presence of phosphorus in the atmosphere from agricultural sources.

Grand Challenge 2 "*We must adapt to and mitigate the impacts of climate change on food, feed, fiber, and fuel systems in the United States.*"

- NRSP-3 monitors climate and climate change~~, simply~~ by monitoring precipitation at approximately 300 sites across the U.S. Therefore, we ~~montitor~~monitor one of the principal factors ~~expectations~~ of climate change ~~(~~,e.g. ~~i.e.,~~ precipitation changes~~)~~.
- As precipitation changes occur, the "chemical climatology" will ~~also~~ likely change. Concentration of pollutants is a direct result of the volume of precipitation, and changes in precipitation (volume) will result in chemical concentrations in the atmosphere. The same is true for deposition rates, which are based on the amount of precipitation that falls. If precipitation depth changes, then deposition rates also will ~~also~~ change.
- The above two changes will result in a change in chemical flow to the agricultural lands of the U.S., and NRSP-3 is in place to measure any differences that can be attributed to changes in precipitation.
- Many atmospheric chemistry reactions are temperature dependent~~ed~~ (e.g., nitrogen). Many scientists expect higher levels of ozone ~~(and others)~~ in the atmosphere which could accelerate the deposition of the resulting pollutants.
- With expected increasing temperatures, more cooling will be needed, and in much of the world, the~~is~~ electricity demand will be met with increasing

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combustion of coal (i.e. India, China). Coal contains many of the pollutants that we measure (e.g., S, N, mercury), and with increasing cooling, a result should be an increase in the deposition of these pollutants. NRSP-3 will be used to track these changes.

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Grand Challenge 3 *"We must support energy security and the development of the bioeconomy from renewable natural resources in the United States."*

- By tracking the movement of S and N compounds, we are documenting the change in atmospheric chemistry and deposition to lands, as the evolution of increasing energy production and electrical needs -move from coal based (high S content) to natural gas (low S content) and biofuels~~, and toward increasing electrical needs to be produced in the near term, primarily by natural gas, and other biofuels~~.
- As biofuel research and production begins, this will include combustion of compounds within the biofuels (S, N, P, etc.), and any changes in the wet deposition from these activities ~~can and~~ will be monitored and recorded by the NRSP-3.
- As biofuel production begins, thisese will require ~~any~~ adaption of agricultural procedures ~~will occur~~ and these adaptations could have impacts upon deposition to surrounding environments. T~~, and t~~he NRSP-3 will be in place to measure any increases or *decreases* of~~in~~ these impacts.
- With the increased ~~implied~~ electrification of the transportation fleet, more power will be needed ~~(see above).~~ These ~~, but will also transfer the~~ transportation emissions will be transferred from ~~the~~ urban corridors (vehicles) to ~~the~~ rural locations where ~~of~~ the production of electricity is generated from biofuels. If any change and movement of these pollutants should occur, NRSP-3 will record that signal, providing required information for agricultural researchers looking for impacts from these changes.

Grand Challenge 4 *"We must play a global leadership role to ensure a safe, secure, and abundant food supply for the United States and the world."*

Work done in the past has shown the movement of agricultural diseases through the atmosphere. If these diseases are water soluble, the NRSP-3 can be used to show their movement, as we did with Asian Soybean Rust spores. NRSP-3 could be used to monitor movement of any number of biological bodies, spores, etc. In the past, w~~W~~e have ~~also~~ proposed ~~in the past~~ to use the assets of the NRSP-3 as~~for~~ an airborne crop disease monitoring network. The ~~key here is that~~ NRSP-3 ~~has a~~ network for observation,

and ~~with~~ the right scientific techniques, allows ~~-~~this observational data to ~~-ability can~~ be used for many different agricultural applications.

Additionally, the ~~It also suggests that~~ NADP data could be used to monitor the increased use of fertilizer and herbicides/pesticides, which are all likely to be required with increasing food needs.

A~~dditionally,~~ an open agriculturally related network also will ~~also~~ allow for easy applications of these types of approaches with the scientists of the SAES system.

Grand Challenge 6 "*We must heighten environmental stewardship through the development of sustainable management practices."*

It seems rather obvious for ~~this~~ Challenge 6 that almost every ~~one of the~~ research article~~s that have~~ us~~inged~~ our data are focusing ~~in part~~ on this Grand Challenge. We have found ~~This is~~ the overwhelming majority of the approximately 1000 articles have~~that~~ ~~we have found that have~~ used NRSP-3 data in their research over the past five years (see https://nadp.slh.wisc.edu/pubs/Annual-Data-Summaries/ ~~for specific bibliography~~). It is ~~also~~ the case that all the articles mentioned in this proposal ~~also~~ supports this Grand Challenge.

Other Challenges Addressed: This listing of grand challenges addressed by NRSP-3 does not discuss the issue of mercury contamination of the soils and fish or the ~~and~~ impact to the health of the nation. ~~that is supported by t~~The three NRSP-3 networks concerned with the movement of mercury (Mercury Deposition Network, Atmospheric Mercury Network, Mercury Litterfall Network)~~. However, these networks to~~ do provide meaningful research data direction to address the Science Roadmap Grand Challenges 4 and 5, concerning health of the national food supply (e.g., mercury ~~principally~~ mov~~ing es~~ into the food chain of fish). Fish are principally harvested, but aqua culture is increasing in importance. Fish consumption is important to many subpopulations, particularly coastal states, and native American subsitence populations.

Overall, one of the principal advantages of the NRSP-3, is that it is a science-based observation network. With its structure, scientific direction, and site locations around North America, the NRSP-3 can be used to make many fundamental measurements in a wide variety of ways to measure the temporal and geographical ~~moment~~impacts ~~-~~of both chemical or biological effects ~~lifeforms in many new ways~~ in ~~to~~ support ~~many challenges to~~ agricultural research~~ers~~. It is ~~also~~ structured for agricultural scientists to

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make these needs known and to test these ideas out relatively quickly through the NRSP designation.

B. Relevance to stakeholders: (8,000 characters)

NRSP-3 provides a collaborative environment to leverage the fiscal, material, human, and intellectual resources of scientists, educators, and policymakers from SAES, universities, government agencies, and non-governmental organizations. Stakeholders include:

- Sponsors that pay for NADP site costs, site operations, etc.
- Site operators contributing efforts in sample collection.
- Cooperators that provide land, electricity, laboratory/office space, and shipping.
- Scientists who use and present NADP data.
- Educators who use NADP data in their classrooms or textbooks .
- Students who use NADP data in the classroom or graduate studies.
- Policy makers who use NADP data to make informed policy decisions ~~on policy~~.

All program stakeholders are invited to attend twice-yearly subcommittee meetings in the spring and fall, (~~usually attended by~~ ~ 75 individuals). Subcommittees receive status and progress reports on network activities, review operations and documents, consider procedure and equipment changes, and propose new initiatives. Many stakeholders are officers and ad hoc members of the committees and subcommittees. ~~The NADP *Quality Management Plan* calls for triennial network laboratory reviews, with reviewers drawn from stakeholders.~~ The NADP *Quality Management Plan* calls for triennial network laboratory reviews, with reviewers drawn from stakeholders.

The Executive Committee (EC) seeks to engage stakeholders in NADP activities. Recent interest has led to investigation of using the NADP to support citizen science ~~(see Fall Meeting 2022)~~, development of the Total N and P measurements ~~(see below)~~, and the breadth of mapping by the Critical Loads (CLAD) subcommittee. ~~Many stakeholders are officers and ad hoc members of the EC~~.

Since 2011, the Total Deposition sub~~C~~committee (TDEP) has developed a new map series of total deposition of N and S through a measurement and modeling "fusion". TDEP has been quite vigorously updating their mapping series and continues to bring in new membership (see reference 37 and https://nadp.slh.wisc.edu/committees/tdep/ ~~for specifics~~).

In the last several years, Aero-allergens (pollen) have been stirring interest among several cooperators and a new scientific AMSC subcommittee was established ~~as a result~~ (https://nadp.slh.wisc.edu/committees/amsc/). AMSC has brought in new members primarily from the health community, with intention of using ~~to use~~ NADP networks as a national atmospheric pollen monitoring network. This effort has made significant progress (38) with the possible use of new technologies in a network. This effort is of ~~should also~~ interest to many ~~new~~ agricultural researchers, since ~~given~~ there is a connection between pollen and agricultur~~eal connection, etc~~.

Stakeholders in the research community can submit a simple proposal to ~~include those~~ us~~eing~~ archived NADP samples for additional research~~, requiring only a simple proposal to NADP~~. Researchers are encouraged to attend NADP meetings and present their findings. Th~~isese~~ ha~~sve~~ sparked new discussionand ~~,~~ new research~~, and more~~. Recent research studies include:

- Applying O^{18} and H^{2} measurements to examine the relationship between precipitation and surface and ground water sources. (39-41)
- Using N^{15} measurements to infer atmospheric NO_x sources. (42)
- Testing for the presence of potentially hazardous chemicals. (43-46)
- Investigating organic nitrogen inputs to total deposition.
- Measuring dissolved Si to understand loads to surface waters in the Midwest.

Stakeholder use of NADP data is assessed by recording website activity, requesting annual participant reports, and performing regular literature searches. This information is summarized in SAES-422 and USDA AD-421 reports~~, etc~~.

Internet disbursement of precipitation chemistry and atmospheric data is the primary route of NRSP-3 data and information. From 2018-2022, NADP estimated over 20,000 measurement data sets were downloaded each year, and approximately 50,000 PDF map images and 100,000 map data sets (grid and kmz)~~ over five years~~. As far as we know, downloads continue to occur at roughly the same rate over the last five years, suggesting~~ again~~ that NRSP-3 remains relevant.

Each year, NRSP-3 summarizes research that develops in whole or in part from NADP data. During the last three years, publication counts have remained high relative to historic counts (since 2007) at about 220 per year. However, 2022 was rather low (183), which may be due to COVID-19 implications. Assuming 2022 was unusual, research use in publications remains consistent, and, again, signals that the NRSP-3 data remains useful and relevant for research support.

NADP data are frequently used to inform and evaluate environmental policies and agreements. NADP maps are utilized in US EPA materials for acid rain deposition and educational materials (https://www.epa.gov/acidrain), and total deposition values mapped by EPA's CASTNET (https://www.epa.gov/castnet), and annual reports (47). NAPAP reports to Congress used NRSP data in assessing emissions changes on deposition on aquatic and terrestrial systems (48). The International Joint Commission uses NADP data in its periodic evaluations of the U.S.-Canada Air Quality Agreement (49) and the Canadian government's deposition assessments (50). Additional regional and state policy assessments, environmental impact statements, and numerous other reports use our data as well (https://nadp.slh.wisc.edu/pubs/nadp-bibliography/).

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Each year, articles with agriculture importance are detailed in the NADP's SAES 422/NIFA REEport. Here are three examples from 2021 and 2022:

1. Zhang, J., Cao, & Lu, 2021. Half-Century History of Crop Nitrogen Budget in the Conterminous United States: Variations Over Time, Space and Crop Types. Global Biogeo. Cycles 35(10): e2020GB006876.

Crop nitrogen budgets are important to agricultural research, and the authors used multiple datasets to examine N budgets for eight major crops in the U.S. at county scale between 1970 and 2019. The authors concluded that N use efficiency has increased from 0.55 kg N/kg N in the 1970s to 0.65 kg N/kg N in the 2010s. Corn, rice, cotton, and sorghum have increased in efficiency, while barley, durum wheat, spring wheat, and winter wheat have decreased. Iowa State University researchers used 16 years of national NTN nitrogen deposition data to estimate total N deposition for every county in the U.S.

2. Bhattarai, A., Steinbeck, Grant, Kalcic, King, Smith, Xu, Deng, and Khanal, 2022. Development of a calibration approach using DNDC and PEST for improving estimates of management impacts on water and nutrient dynamics in an agricultural system. Env. Mod. & Software 157: 105494.

The authors (Ohio State, ARS) focused on a modeling study of the biogeochemical DeNitrification DeComposition (DNDC) model in an agriculture situation in Ohio. The goal was to test three model calibrations to determine which was best. They also tested the effectiveness of the PEST parameter estimation software. Several model parameters were shown to be very influential, while corn yield was most sensitive to accumulative temperature and grain carbon to nitrogen ratio. The researchers used repeated years (2014-2020) of NADP's weekly data from a NE Ohio site (IN41).

3. Waiker, P., Ulus, Tsui, and Rueppell, 2022. Mercury accumulation in honey bees trends upward with urbanization in the USA. Ag. & Env. Letters 7(2): e20083.

With this very interesting idea, the authors theorized and found that honeybee (Apis mellifera) mercury concentrations, in part, were explained by the urbanization of the landscape. In their small sample, they did find that honeybee concentrations tend to increase with urbanization, although the low sample numbers. Methyl mercury (organic Hg form) was undetectable in the samples. The authors conclude that "urbanization may play a role in increasing Hg exposure to these pollinators", and honeybees could be a useful biomonitor for pollutants. The authors used seven NADP Mercury Deposition Network sites to associated mercury deposition to the concentrations in bees.

It is ~~also~~ important to note that as of the last three months, we have started to build a new database system that will allow for ~~all to~~ searches of all of the publications that have used NADP data. This is complete ~~done~~ for the 2022 year (https://nadp.slh.wisc.edu/pubs/bibliography_search/), and over the next several months we will collect and add ~~all of~~ the previous years starting in 2007 ~~(when this type of counting started)~~, and will add ~~in~~ the 2023 publications ~~list when this counting is done at~~after the year's end.

Of special note is the particularly important role that SAES and off-the-top funding plays in NADP. The SAES funding provides three very important advantages:

(1) it enhances the ability of the SAES to address pressing needs of agriculture,

~~-~~(2) it controls NADP site loss due to lower costs for SAES participation, and

~~-~~(3) it leverages SAES funding ~~is heavily leveraged~~ by allowing participation of other federal and state agencies.

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All NADP sites pay a management fee for operations. The SAES funding pays some of this fee for the SAES sites (evenly divided, essentially applying a "discount" to each site). The remaining costs are borne by the individual SAES. With a loss of NRSP status, the operational costs at all sites would increase significantly and many sites located in the agricultural production areas could potentially be shut down.

Implementation:

A. ~~A.~~ Objectives and Projected Outcomes: (4,000 characters)

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Objectives

1. Characterize geographic patterns and temporal trends in chemical or biological atmospheric (wet and dry) deposition.
2. Support research activities related to: (a) the productivity of managed and natural ecosystems; (b) the chemistry of surface and ground waters, including estuaries; (c) critical loads in terrestrial and aquatic ecosystems; (d) the health and safety of the nation's food supply; and (e) source-receptor relationships
3. Support education and outreach through the development of informational materials and programs aimed at people of all ages.

Projected Outcomes

NADP provides timely deliverables of data free of charge. Stakeholders are encouraged to access data from the NADP website (http://nadp.slh.wisc.edu/). This site offers on-line retrieval of individual data points, seasonal and annual averages, trend plots, concentration and deposition maps, reports, manuals, educational brochures, and other information about NRSP-3. Quality-assured data and information from all networks are loaded quarterly into the on-line database system with a lag of ~180 days. Information available from this website and linked database management system constitute the deliverables that support the project objectives. NADP ~~also~~ addresses special request data products, answers scientific questions, and assists users to find related information. Complementing the on-line data and information are publications such as annual data summaries, annual meeting proceedings and presentations, quality assurance documents (e.g., QMP), manuals, informational and educational brochures, and reports. All publications are available online (http://nadp.slh.wisc.edu/lib ~~nadp.slh.wisc.edu/lib/~~).

To assess the type and amount of research activity supported by NRSP-3, participants are asked to annually report their program activities and publications that use NADP data ~~annually~~. Additionally, information is obtained from online literature repositories to locate all publications that reference or use NADP data, maps, and other information. These are summarized annual and provided on the NADP website (http://nadp.slh.wisc.edu/lib/bibliography.aspx), providing for a testable deliverable. More than ~95% of these publications are peer-reviewed journal articles and reports,

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and also includes ~~as well as~~ masters and PhD theses and dissertations covering a vast range of research areas. The balance includes informational pieces, such as newspaper reports. Over the last three total years (2020-2022), publications listed have numbered 217, 223, and 183 publications, respectively. This demonstrates that NRSP-3 is achieving the primary goals of NRSPs, namely, to support research (and NADP's Objective #2).

Program Improvements and advancements: Objective (1) was changed during the 2002-06 funding period to "chemical or biological atmospheric (wet and dry) deposition". This objective now explicitly mentions wet and dry deposition, including the (biological) deposition of plant pathogens (earlier) and pollen. Current networks ~~to~~ measure air concentrations of ammonia and mercury make possible the estimation of dry deposition fluxes and ~~,~~ build~~sing~~ new research support capacity. Research activities under objective (2) were amended to address emerging interest in critical loads and the health and safety of the nation's food supply (mercury) ~~in previous years~~. During this period, a large part of the network changes have been towards monitoring for more N compounds (agricultural needs), and Black Carbon deposition (related to climate) and PFAS compounds ~~(discussed elseward)~~. In summary, there has been a focus of making more measurements with the same activities and making a ~~, or~~ a more efficient network. Including the health of food supplies embraces the work currently being done to understand mercury ~~sources~~sources.

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We feel that we have met all our goals for the current period~~. We feel that we have met~~and ~~all of our goals during~~ the previous year ~~(see surrounding discussion)~~, and that all of our data was in place on time and ~~was~~ used for research in many different agricultural areas. We can always make better use of our assets and will strive to continue to improve.

B. Management, Budget, and Business Plan: (16,000 characters)

Project Management and Business Plan: Project management of NRSP-3 is described in the *National Atmospheric Deposition Program Governance Handbook* (https://nadp.slh.wisc.edu/pubs/brochures/). This handbook defines the roles and responsibilities ~~of the members~~ of the Executive Committee, the Program Office, and all committees and subcommittee~~, and their respective areas of responsibility, etc~~. Each role is briefly summarized in the following sections.

The NADP Program Office (PO), located at the Wisconsin State Laboratory of Hygiene (WSLH) at the UW-Madison, is responsible for promoting long-term NADP operations

that comply with the operational procedures and quality-assurance standards set by the Executive Committee (EC), with guidance from its subcommittees. The PO manages day-to-day network operations. The PO responsibilities include:

1. Securing site support, chemical analytical, and data validation services for NADP measurement programs.
2. Ensuring measurement programs produce consistent quality-assured data.
3. Managing the NADP databases and website.
4. Publishing annual map summaries, data reports and other miscellaneous documents.
5. Providing support for committee and subcommittee meetings.
6. Coordinating any special studies.

The NADP Coordinator is the PO Director and works in parallel with the principal investigator of the cooperative agreements between NADP sponsors and the UW-Madison. At least three times per year, the Coordinator reports to the EC on the status and progress of PO and NADP activities.

Budgeting is on a federal fiscal year basis. The Coordinator reports on the fiscal status of the project to the Budget Advisory Committee (BAC), which is responsible for financial planning. The BAC reviews the Coordinator's report and the Coordinator's income and expenditure plans for the upcoming fiscal year. The BAC makes its budget recommendations to the EC, which has budget approval authority. BAC membership consists of elected and ex-officio members and includes the USDA-NIFA representative (A. Ganguli). The WSLH develops an annual budget that is reviewed and approved by the WSLH Board of Directors, applying a high degree of oversight on the program. As part of the review, the NADP PO develops a balanced budget based on projected income and expenditures and a detailed cost analysis. This approved budget is then presented to the BAC. The budget is continually reviewed by PO and laboratory mangers to ensure operations remain within the approved budget.

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The Executive Committee (EC) is responsible for making policy decisions, budgetary decisions and ensuring program continuity and balance for NRSP-3. It provides technical and administrative guidance to the PO. The EC receives input and recommendations from the BAC on budgetary matters and the Quality Assurance Advisory Group on quality assurance matters. It ~~also~~ receives input and recommendations from two standing technical sub~~sub~~committees:

- The Network Operations SubSubcommittee (NOS), which oversees field-siting criteria and laboratory and sample collection protocols, and evaluates equipment and recordkeeping methodsmethods.
- The Education ecological Responses and Outreach SSububcommittee (EROS), which provides input on data user needs, and initiates and develops educational materials and programs orand products to promote the program and increase participationparticipation.

The EC acts on recommendations and sets program policies and procedures. EC membership consists of four elected officers, the elected chairs of each of the technical technical subcommitteees, the BAC co-chair, and a SAES representative, all of whom have voting privileges. Membership also includes ex-officio non-voting members, such as the SAES Regional Administrative Advisors, the NIFA program manager and the science committees. , etc. Membership in NADP the technical subcommittees is open and members may participate on any subcommittee or ad hoc group. the rosters range from 40 to 60 per committee. Summaries of EC minutes, technical subcommittes, and science committees are provided on the web (https://nadp.slh.wisc.edu/committees/), along with all subcommittee minutes.

TAs mentioned previously, the EC has continuesd to look for ways to engage new participation in its technical subcommittees, science committees, and annual meetings. In recent years, EC has added several science committees, who focus on scientific topics (cCritical loads (CLAD), total deposition (TDEP) , mercury (MELD), aeroallergens (AMSC), urban monitoring (CitiDep), etc.) with varying success. Over the years, the focus has primarily been sulfur and nitrogen (see https://nadp.slh.wisc.edu/committees/tdep/), and is a good example of how more information (dry deposition estimates) of S and N, leverages by and for the benefit of agricultural researchers.

Linking multiple funding sources

The NRSP-3 project has had multiple sources of funding, since the beginning of its operation, and at least since the 1980s. Currently, the NRSP-3 is directly funded by approximately 100 agencies and groups, and funding is ~ $3 million per year. Included in these agencies is the SAES (1.6% of total budget), seven federal agencies (~56%), approximately 30 state agencies (~35%), and miscellaneous universities, local, and tribal government agencies, environmental institutes, private companies and other research organizations (~5%). In FY23, there are 103 organizations that cooperatively fund the NRSP-3. All this money is leveraged from the original decision of the SAES station research idea, multiple long-term commitment of all organizations, and the designation

of a national research support project. The key our success and longevity is truly the NRSP designation.

The base funding provided by the OTT MRF funding is extremely important to this project. Beyond the base funding for SAES stations (used to pay some of the management fees), this funding confers the national research support designation. This NRSP designation allows for direct support by the USDA-NIFA. NIFA then allows for federal and state agencies to cooperate with it in the project, which is the key to our multi-funder set up and long-term success.

There are no plans to change our multidisciplinary funding mechanism, and our commitment to allow ~~any and all~~all organizations to join with us in future funding.

Contributions by SAES

As mentioned previously, the SAESs operate, and have operated our longest operating monitoring stations with the NTN. Of our current 260 NTN sites, 54 of these are either sponsored or operated by SAESs, and located at land-grant universities (see a new interactive map here https://www.google.com/maps/d/u/0/viewer?mid=1-1YiEFtbqAjIg_Pqf_TS7jZ2vyyXPyU&ll=40.105997047819784%2C-83.33217015608807&z=5). These agricultural sites are located in all four SAES regions, with 41 of 54 sites having a 40+ year operating records.

Along with basic financial support, it is worth noting that these SAES sites provide operators and, in almost all cases, pay the salaries of these operators. They ~~also~~ provide electricity and site locations, weekly maintenance~~attention~~ of~~to~~ the samplers, mailing services, and management (there is an operator and a supervisor usually located at the SAES.

Agricultural research scientists ~~also~~ use our data every year, and these research publications are specifically highlighted annually in our NRSP reporting with the SAES and USDA systems (NMISS and REEport). Additionally, the SAES Administrative Advisors have been long-term supporters and active members of the management of the program. Since about 2007, Dr. Buhler has been a very active member of our meetings (Spring, Budget, Fall). Dr. Payne has ~~also~~ been active, particularly during our recent move (2017/2018) from the University of Illinois to the University of Wisconsin Madison. Drs. White and Xia are relatively new but have already started to participate (midterm review). Dr. G. Hopper/Mississippi State was a particularly good advisor ~~also~~, but he has since retired.

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The long-term SAES Community Representative (Dr. Richard Grant/Purdue University) has been an active member of the NRSP-3 for many years, and has been present at almost all meetings and been an officer of the EC twice.

Additionally, we have the support of the SAES here at UW-Madison. I understand they were active and agreeable to the project move from the University of Illinois, supportive of our sites in the SAES system and state, and supportive of the administrative functions (financial) with the OTT funds. We ~~also~~ have a good working relationship with the Soils and Forage Analysis Laboratory of the SAES system at UW Madison.

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A summary for capacity and modest requested support for the NRSP-3, is as follows:

- NRSP-3 continues to support nationally important areas of research, addressing multiple Grand Challenges, and other areas of important research.
- Each year, numerous agricultural research journal articles are listed, as a specific and concrete example of the SAES mission for national research support projects.
- We provide a monitoring network useful to all agricultural regions, many SAES sites, and open to ~~any and all~~all agricultural research establishments.
- We have highly leveraged SAES funding ($50,000) to $3.0 million per year through its 100 direct support collaborators.
- We make basic measurements that can be used in a myriad of research ~~areas, and~~areas and have a 40+ year record of consistent and valid monitoring.
- Given our active and widespread availability of people and monitoring ability, we have the capacity to grow to meet any current need or future unseen need, with proposals made by all agricultural scientists.

Project Budget: NRSP-3 provides the authority and framework for combining the resources of many diverse sponsors in support of NRSP-3. Project support is divided into monies administered by the UW-Madison Research and Sponsored Programs (RSP) and the monies and in-kind support for operating NADP site subscribers. Cooperative funds administered by RSP provide the resources for the PO to perform duties and obligations required to satisfy the six responsibilities listed above. Subscriber support site operations including cost of sample collection, transportation and electricity to run the site, sample shipping, and land access and office space. Support for site operations is not administered by WSLH but is provided through an agreement described in the "NADP Shared Services and Responsibilities" document.

Three funding streams provide support for the PO: (1) SAES off-the-top monies, (2) a cooperative agreement between the USDA-NIFA and UW-Madison RSP, and (3) agreements between individual SAES, universities, government agencies, or non-governmental organizations and the WSLH. The USDA-NIFA/ UW-Madison RSP cooperative agreement combines the support of six federal agencies (BLM, NOAA, NPS, USDA-Forest Service, USGS, and ARS), along with USDA, each having an interagency agreement with the USDA-NIFA. Each individual (type 3) agreement funds one or more sites.

Hatch funds provide off-the-top support and the land-grant university support of SAES sites. Since these funds can pay only direct program costs and under the NRSP-3 are combined with funds from other sources, all PO support, no matter the source, pays only direct program costs. Indeed, the USDA-NIFA/UI cooperative agreement stipulates that monies be used only for direct costs and not for facilities and services. Total FY22 support from these three funding streams was $2.91 million. From FY19 to FY24, off-the-top support remained constant at $50,000. Therefore, over the years, SAES funds have been highly leveraged into an internationally successful NRSP.

NRSP-3 off-the-top monies provide partial support of the Program Coordinator. Since this position spearheads day-to-day outreach to new stakeholders and development of innovative data products that support new research interests, we propose a level NRSP-3 budget of $50,000 per year for the FY24-FY28 renewal period.

The NRSP-3 funding model has enabled project growth and diversification of funding sources (see previous section). The NTN is currently at 261 sites (very stable over the last 15 years). For the network to maintain its size and potentially grow the program, it must contain costs and gain efficiencies in network operations. All funding support leads to reduce per site fees, thus encouraging additional involvement in NADP. With the addition of the AMoN ammonia network, site numbers have increased rapidly to approximately 100 sites, including three sites operated by SAES scientists (AR, CO). Many of the sites are federal sites, with support from US EPA and the National Park Service, again showing leveraging of SAES support to other agencies with support SAES national priorities.

With the addition of the MDN (mercury deposition) in 1996, the number of individual (type 3) agreements has risen to current 85 sites. MDN support comes largely from state, local, and tribal government agencies in states confronting a growing number of health advisories because of mercury-contaminated fish. PO outreach efforts have been successful in enlisting new MDN support from these agencies. MDN is currently at 100 sites, most in the U.S., several in Canada (six sites), and within Tribal Nations (13 sites).

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This network effort supports the Grand Challenge 1, 4, and 5 (food sources, although not always agriculturally derived).

The NRSP-3 committees and PO continue to look for ways the project can serve regional and national needs. Partnering with USDA-ARS to use NADP samples for detecting ASR spores in precipitation was a very good use of the networks in the past. Initiating the AMON has demonstrated the viability of cost-efficient passive sampling methods for measuring ambient ammonia and is responding to the national need to better understand ammonia sources, atmospheric cycling, and deposition. This ~~was (and~~ is~~)~~ a useful agricultural use of the networks. This network shows a strong potential for future growth. Several other potential uses of the networks and agriculture have been identified in other section of this report.

These and other efforts remain true to the vision that NRSP-3/NADP will remain one of the nation's premier research support projects, serving science and education, and supporting informed decisions on air quality issues.

The requested project budgets and specific budget narrative are in the appendix of this report.

C. Integration and Documentation of Research Support: (5,000 characters)

Academic Programs: Data and information on the NADP website have become an important resource for educators at virtually every level. Users indicate that approaching 50% access on the site for educational purposes and the balance for research from academic institutions, with significant growth since the early 2000s (38% education). In 2017 (the most recent access), total data downloads were identified as follows: 40% from federal and state agencies, 36% from universities, 16% from K-to-12 schools, and 6% from other individuals or organizations. We expect that these percentages are about the same, given their consistency over the years. These traditional tracking values have not been available at UW Madison. However, our new effort in the next 12 months (google analytics, mentioned previously) should give us a deeper insight into this type of tracking.

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NADP data have been used for approximately 10-15 theses/dissertations each year. Over the last 10 years, authors have used NADP data, figures, and maps in undergraduate textbooks in biology, chemistry, environmental sciences, and related

areas (54, 55). There are even used occasionally undergraduate honors theses (51). The NADP willingly supplies high quality graphics and data free of charge for these efforts. Secondary-level students continue to access on-line brochures, data and maps for use in science fair projects and classroom exercises.

NADP staff has been involved in extension work with Native American organizations concerning primarily mercury, motivated by the high tribal levels of fish consumption. NADP continues to contribute to the Institute of Tribal Environmental Professionals, National Tribal Air Association, and Tribal Air Monitoring Support Center. Additionally, over the last several years, NRSP-3 has worked within a project with U.S. EPA to further tribal monitoring within their own lands, including further NADP monitoring. Currently, the NRSP-3 cooperates with 22 separate Native American tribes who operate at least one network site in one network, while several run multiple networks.

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Past and Ongoing Partnerships:

- The NADP partnership with the ARS Cereal Disease Laboratory at the University of Minnesota to quantify SBR in precipitation samples continued through 2011. This project was previously described in the National Relevance section.
- During 2010 to 2012, the NADP has adopted the PRISM (Parameter-elevation Regressions on Independent Slopes Model) method for developing deposition map products. PRISM data sets, based at Oregon State University, are recognized as being of very high-quality and are supported by the USDA Natural Resources Conservation Service, USDA Forest Service, and the NOAA Office of Global Programs.

Current Partnerships:

- The NRSP-3 collaborated with numerous external monitoring and research organizations including a partnership with the 2015 Acid Rain conference (New York State), and most recently with the 2022 Acid Rain conference, held is Niigata Japan. This meeting was in cooperation with the EANet Program (NRSP-3 like in Asia), and the Japan Ministry of Environment.
- The NRSP-3 is working directly on QA intercomparisons with the National Ecological Observatory Network (NEON) on improving mercury deposition measurements for both networks and comparability between the networks. NEON representatives have ~~also~~ recently attended several NADP fall meetings.
- The AMON and AMNet were developed at the request of stakeholders to address the needs of the agricultural research community. In both cases, these newer

networks have brought in new site and funding partners, and new researchers. AMON is of particular interest to SAES scientists (discussed elsewhere in this report).

- Cooperation with Mexico: The NRSP-3 is working directly with Dr. Rodolfo Sosa/National Autonomous University of Mexico (Mexico City), to help the Country of Mexico develop a similar NTN-like network for Mexico. The idea is currently at the proposal stage with much work left to do. But our goal is to help get the network operating on a status equivalent to NTN, making intercomparison of data directly possible. In the last two semesters, two graduate students have come to the U.S. to study our methods, which seem to have been valuable. More will be reported here in later annual reports.
- Other cooperative projects have been described earlier, including the new Aeroallergens subcommittee and cooperation with health professionals, the Total N and P sampling, working with the National Park Service, and SAES scientist Dr. J. Collett at Colorado State University, etc.

Support Nationwide Research: NADP data users are in every state and data is actively downloaded by international researchers. The NADP is in the majority of U.S. states and in Canada, Puerto Rico, and the Virgin Islands, and we collaborate with nations including Mexico, Japan, China, South Korea, and Taiwan. The AMON has 100 sites in 39 states and Canada (including all four SAES regions), with preliminary gaseous ammonia measurements extending back to 2007 and official network measurements beginning in 2010. The number of active data users and monitoring sites provide indications of the breadth of support and continued interest in NRSP-3, and recognition that NADP is responsive to emerging needs of researchers and policymakers. The breadth of reports and journal articles using or citing NADP data demonstrates the nationwide, indeed international, use of NADP data.

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D. Outreach, Communications, and Assessment: (15,000 characters)

Outreach, Communications and Assessment

Audience: The NRSP-3 mission is to provide quality-assured data and information on atmospheric deposition for use by scientists, educators, students, policymakers, and the public. **The NRSP-3/NADP has effectively supported outreach and routinely assesses the impact of these activities through quantifiable metrics.**

The NADP website provides on-line access to virtually all project data and information, including educational and informational brochures. All data from all networks is freely

available to all interested users through the website (https://nadp.slh.wisc.edu/). This includes the 500,000+ samples for precipitation chemistry and wet deposition collected thus far over all regions of the U.S. and now Canada.

Download web statistics have been presented previously. User statistics show the continual growth in the number of registered users and data downloads, two indicators of the importance and relevance of the data.

In its role of assessing project performance, the NRSP-3 Executive Committee charged the PO with updating the website to improve the organizational layout, facilitate data and map accessibility, enhance communications, and modernize the "look and feel". NADP has received beneficial feedback through its EOS ~~(formally EROS) subcommittee~~ as to best structure the materials to meet the needs of stakeholders. The second ~~version, or the rebuild of this~~ webpage ~~-~~update ~~(due to the 2018 move to Un. Of Wisconsin Madison)~~ was ~~is now~~ completed in 20**(*date*) and available. The new website design has been put in place, including sections featuring:

- Education, with new materials for classrooms at the 4th to 6th grade and senior high level
- News section, where NADP can highlight new happenings with the network, and all current subjects get added to the website quickly
- Committees section, where mission statements and topics of discussion, minutes, and related materials are located
- Publications section, including all NADP standard operating procedures, minutes, and presentations from meetings, etc.)
- Operators section, which is new in the last year is a section specifically for all site operators, including standard operating procedures, tools for uploading field data, training videos (new to the project), and a section for starting new sites

Engagement of Stakeholders: Stakeholders are ~~-~~involved~~ment~~ in committee and subcommittee activities, and ~~-at~~ twice yearly meetings as previously described ~~previously~~. In addition, members participate in triennial laboratory and quality management reviews, where they provide recommendations for improvement. Committees and subcommittees identify emerging scientific needs and interests, where all stakeholders are welcome. For example, the AMoN, AMNet, and the new ~~Aeroalergens~~Aeroallergens subcommittees originated with committee discussions. As mentioned in "Management, Budget, and Business Plan," the committees continually seek increase participation from land-grant university scientists, especially at annual technical meetings.

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NADP actively supports engagement with stakeholders, for example at the 2019 Fall Science Symposium and Meeting, NADP through direction of its federal partners is hosted a NADP TDep Workshop "Connecting Stakeholder and Science Perspectives to Better Understand the Linkages Between Agriculture and Reactive Nitrogen Deposition". These special meeting workshops have been held in the past, including one recently on agricultural ammonium.

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Measuring Accomplishments: Methods to measure program outputs, accomplishments, and impacts have been described in previous sections of the proposal and include:

1. An annual request to all program participants to send a list of accomplishments and publications utilizing NADP data to the PO.
2. Routine searches of scholarly repositories, journal articles, and professional reports.
3. Compilations of web user statistics.
4. Identification of NADP data use in policy-related documents and websites, ~~e.g.~~e.g., NAPAP reports, NRC reviews, government agency reports and websites.
5. Participation in NADP meetings.
6. Routine program reviews.

Many of these have been discussed in other parts of this proposal.

Communication Pieces: The NADP's principal data product is its annual map summary report, which provides a summary of annual highlights and map products. This summary is distributed at scientific meetings and is mailed to all program participants. This year (2023), a new feature is a digital document meant to be read online in a "reading format" (see https://heyzine.com/flip-book/796fbdb6dc.html). This is designed to make it more available to younger scientists who, effectively use electronic s~~no longer use paper~~ documents. Additional publications are available on the NADP website and in print form:

1. ***Welcome to NADP***, which describes the program to "newcomers", encourages their involvement, and is regularly updated with upcoming meeting dates.
2. ***Nitrogen From the Atmosphere***, *which is a redesign and rewrite of* ***Nitrogen in the Nation's Rain*** (early 2000s document), with a focus on the gaseous constituents, how nitrogen actually gets into precipitation, and an additional focus on dry deposition of nitrogen along with wet deposition;
3. ***Critical Loads: Evaluating the Effects of Airborne Pollutants on Terrestrial and Aquatic Ecosystems,*** where this brochure outlines the function of NADP's

Critical Loads Scientific Subcommittee, outlining their products (mapping of critical loads for forests primarily for N, etc.);

4. An updated ***Ammonia Monitoring Network (AMoN) Fact Sheet,*** which describes issues related to gaseous ammonia, and provides an overview of methods and measurements in the AMoN; and
5. ***NADP's Governance Handbook***, providing the structure and operation of NADP's officers, committees, and organization (continually updated), providing a primer for stakeholders, students, and new scientists of the structure and operation of NADP (provided at meetings).

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Distribution of Results: As described in previous sections of this proposal, NADP data are distributed primarily via the NADP website, which offers easy-to-use on-line retrieval of data in multiple formats. During 2022, NADP estimated ~20,000 comma-delineated data sets were downloaded, including 14,000 from the NTN database.

In addition, during the next 12 months, with support from UW-Madison computing, NADP would like to add Google Analytics (or similar) to our website. This software is sold as marketing software, but we will use it to give a much deeper insight into who is visiting our website, provide a better understanding of what users are looking for, and very specific counts of what webpages are being read, what is being downloaded, etc. This type of information is~~will be~~ very valuable in reporting (as with this report), ~~but also~~ and for the~~our~~ Education Subcommittee (EOS) to ~~for~~ fulfill~~ing~~ its~~their~~ goals.

Every year, a scientific symposium is held where presenters summarize the results of their scientific studies that use NADP data. The FY17 through FY23 Fall Scientific Meetings were held in in San Diego CA, Boulder, CO, Knoxville TN, ~~Boulder CO~~, and Madison WI, and online during the ~~due to~~ COVID-19 pandemic~~for several years~~. A typical Fall Symposium has approximately 150 attendees, and 20-30 students. Since we are an NRSP, it is important to the committees to move the meeting around the country so that new attendees and students living near the meeting ~~(and students)~~ will be more likely to attend. ~~All of~~All our meetings, with attendees' listings and presentations, can be found here (https://nadp.slh.wisc.edu/conferences/).

E~~Additionally, e~~ven though COVID-19 ~~did~~ presented many difficulties and challenges~~in many areas~~. However, it did teach us a the ~~few~~ advantages to online meetings efficiently and developing training that could be accessed anytime.. The technical challenges of ~~se can be qu~~combining ~~ite difficult when dealing with~~ both live and online presenters, making sure everyone could ask questions and be heard, etc. But, we have now learned how to hold these meetings relatively well, and we will continue to hold hybrid meetings. Especially important here is the number of non-North

American attendees that were present (China, Japan, Taiwan, Mexico, Peru, various European countries, Canada).

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Appendix F: Budget

Project Title: NRSP003 - The National Atmospheric Deposition Program (NADP)

Requested Duration: October 1, 2024 to September 30, 2028 (FY24-FY28)

Budget & Narrative

In support of the NRSP-3 application, we present the following budget and narrative description.

The MRF funding will be used for salary support for one person at the Program Office of the National Atmospheric Deposition Program. This support for the Program Coordinator will go towards the management of the project, and support the positions most responsible for carrying out the outreach and communication mission of the NRSP. This funding will provide approximately one-half of the salary and benefits for this employee. The FY24 salary figure represents salary for the Program Coordinator, based on current FY23 salary. Other non-salary funding is not being requested.

The "Other Sources" table also contains a few assumptions and requires further explanation. These values include all funding categories listed (industry, federal agencies, grants/contracts, and SAESs). Therefore, this table represents the total project budget plus the SAES funding (approximately 1.6% of the total budget). This budget begins with the approved 2020 budget value. With these assumptions, annual values are estimated for the next five funding years.

Additional categories were added to this table to demonstrate itemized costs important to this project. The total wages (fringe plus salary) are reported are the sum of the Salary and Fringe lines. The total FTE represent all projected PO and laboratory personnel required to successfully operate the program. Supplies and services include all contractual services and the supplies for PO and laboratories including printing and laboratory supplies to operate during the project period. Maintenance and repair includes equipment upkeep (maintenance contracts and repairs), depreciation on equipment, building changes and upkeep and the like. Communication include the cost of office communication including operation of the site liaison 800 number, and some printing. Travel and training includes costs associated with the spring and fall meetings as well as cost for outreach such as at national conferences. Rent and overhead cover the small cost of building rent, and overhead associated with WSLH support including NADP subscriber billing (financial), purchasing services, human resources services, and information technology services (computing, web).

NRSP-3, The National Atmospheric Deposition Program (NADP) - A Long-term Monitoring Program in Support of Research on the Effects of Atmospheric Chemical Deposition										
DESCRIPTION	**Proposed FY20**		**Proposed FY21**		**Proposed FY22**		**Proposed FY23**		**Proposed FY24**	
	Dollars	**FTE**	**Dollars**	**FTE**	**Dollars**	**FTE**	**Dollars**	**FTE**	**Dollars**	**FTE**
Salaries	37,600	0.6	37,600	0.6	37,600	0.6	37,600	0.6	37,600	0.6
Fringe Benefits	12,400		12,400		12,400		12,400		12,400	
Total Wages (Salary and Fringe)	50,000		50,000		50,000		50,000		50,000	
Supplies & Services	0		0		0		0		0	
Maint. & Repairs	0		0		0		0		0	
Communication	0		0		0		0		0	
Travel & Training	0		0		0		0		0	
Rent & Capital Equip. Dep.										
TOTAL	50,000	0.6	50,000	0.6	50,000	0.6	50,000	0.6	50,000	0.6
OTHER SOURCES OF FUNDING **Other: EPA, USGS, ARS, USFS, US Park Service, BLM, NOAA, States, Tribes, Canada, Industry, NGOs, etc.**										
DESCRIPTION	**Proposed FY24**		**Proposed FY25**		**Proposed FY26**		**Proposed FY27**		**Proposed FY28**	
	Dollars	**FTE**	**Dollars**	**FTE**	**Dollars**	**FTE**	**Dollars**	**FTE**	**Dollars**	**FTE**
Salaries	1,400,000	25.3	1,400,000	25.3	1,400,000	25.3	1,400,000	25.3	1,400,000	25.3
Fringe Benefits	486,000		486,000		486,000		486,000		486,000	
Total Wages (Salary and Fringe)	1,886,000		1,886,000		1,886,000		1,886,000		1,886,000	
Supplies & Services	426,000		426,000		426,000		426,000		426,000	
Maint. & Repairs	322,000		322,000		322,000		322,000		322,000	
Communication	5,000		5,000		5,000		5,000		5,000	
Travel & Training	47,000		47,000		47,000		47,000		47,000	
Rent, Overhead & Capital Equip. Dep.	173,000		173,000		173,000		173,000		173,000	
TOTAL	2,859,000	25.3	2,859,000	25.3	2,859,000	25.3	2,859,000	25.3	2,859,000	25.3

NRSP Review (Submitted)

Project: The National Atmospheric Deposition Program (NADP)

Dates Covered 10/01/2024 - 09/30/2029

The following statement defines the mission of the National Research Support Projects (NRSP's):

NRSP Mission: National Research Support Projects (NRSPs) focus on the development of enabling and critical technologies (e.g., databases, cyberinfrastructure, on-line toolkits, reagents), support activities (e.g., collect, assemble, store, and distribute materials, data, resources or information) or the sharing of facilities (e.g., analytical equipment, lab, field) needed to accomplish high priority research.

Based on this mission, please rate the proposed NRSP using the following criteria.

	Satisfactory	Unsatisfactory
Mission:		
Consistency with the NRSP mission	◉	○
Relevance:		
Addresses and supports a high priority national issue	◉	○
Demonstrates clear and tangible benefits to the scientific community as a whole	◉	○
Clearly identified sponsoring beneficiary stakeholders	◉	○
Stakeholder involvement in project development, project activities, review, and/or management plans	◉	○
Technical Merit:		
Overall technical merit (sound scientific approach, achievable objectives, review, and/or management plans	◉	○
Potential for significant outputs (products) and outcomes with impacts	◉	○
Implementation Plan:		
Benchmarks for success clearly identified	◉	○
Management structure that adequately coordinates efforts of multiple participants	◉	○
Well-developed business plan that captures multiple sources of funding and leverages OTT MRF	◉	○
Funding plan that develops alternative funding sources to reduce OTT MRF in future years	◉	○
Efforts integrated with Extension, academic, or international programs	◉	○
Outreach, communications and assessment plan that communicates the program goals, accomplishments, and outcomes, and impacts	◉	○

Comments (Please add general and specific comments on strengths and weaknesses of the proposal, including specific revisions that would improve the proposal):

Submitted on behalf of Melissa Puchalski, CASTNET Program Manager, USEPA.

Please note that she sent a track changes version with minor edits to the current proposal to Dr. David Gay. Overall it is well written and adequately describes the scientific and programmatic benefits to the community.

Overall Recommendation: Approve with Revision

Report a Bug

NRSP Review (Submitted)

Project: The National Atmospheric Deposition Program (NADP)

Dates Covered 10/01/2024 - 09/30/2029

The following statement defines the mission of the National Research Support Projects (NRSP's):

NRSP Mission: National Research Support Projects (NRSPs) focus on the development of enabling and critical technologies (e.g., databases, cyberinfrastructure, on-line toolkits, reagents), support activities (e.g., collect, assemble, store, and distribute materials, data, resources or information) or the sharing of facilities (e.g., analytical equipment, lab, field) needed to accomplish high priority research.

Based on this mission, please rate the proposed NRSP using the following criteria.

	Satisfactory	Unsatisfactory
Mission:		
Consistency with the NRSP mission	◉	○
Relevance:		
Addresses and supports a high priority national issue	◉	○
Demonstrates clear and tangible benefits to the scientific community as a whole	◉	○
Clearly identified sponsoring beneficiary stakeholders	◉	○
Stakeholder involvement in project development, project activities, review, and/or management plans	◉	○
Technical Merit:		
Overall technical merit (sound scientific approach, achievable objectives, review, and/or management plans	◉	○
Potential for significant outputs (products) and outcomes with impacts	◉	○
Implementation Plan:		
Benchmarks for success clearly identified	◉	○
Management structure that adequately coordinates efforts of multiple participants	◉	○
Well-developed business plan that captures multiple sources of funding and leverages OTT MRF	◉	○
Funding plan that develops alternative funding sources to reduce OTT MRF in future years	◉	○
Efforts integrated with Extension, academic, or international programs	◉	○
Outreach, communications and assessment plan that communicates the program goals, accomplishments, and outcomes, and impacts	◉	○

Comments (Please add general and specific comments on strengths and weaknesses of the proposal, including specific revisions that would improve the proposal):

The NADP provides unique data on amounts and geographic distribution of chemical deposition and is an important national research asset. Initiated by SAES in 1978, NADP has compiled a long-term record, which has become increasingly important to assess environmental trends. NADP data are key to agricultural research across a broad domain, including nutrient budgets, ag emissions (especially the continued and increasing importance of ammonia / ammonium deposition), and impacts of deposition on both managed and unmanaged ecosystems. It also has been deployed to address emerging issues, such as Asian Soybean Rust, and the long-term precipitation records of NADP contribute an important foundation of climate data for climate-change research. NRSP support has helped leverage multiple sources of funding. NADP data are very important to the scientific community.

(This review was submitted by Chris Hamilton on behalf of Rich Kobe, Professor and Chairperson, Department of Forestry, MSU.)

Overall Recommendation: Approve

Report a Bug

NRSP_temp3: The National Atmospheric Deposition Program (NADP)

Status: Draft Project

Duration	10/01/2024 to 09/30/2029
Admin Advisors:	[Douglas Buhler] [Jason C White] [Kang Xia] [William Payne]
NIFA Reps:	

Non-Technical Summary

The National Research Support Project-3 (NSRP-3) is a long-term project designed to provide research quality data to SAES scientists to address many national needs, agricultural grand challenges, and research needs. Our primary goal is to measure the rate of pollution deposition onto U.S. agricultural lands (i.e., pollution falling onto the surface with precipitation). We measure the deposition rate of sulfate, nitrate, ammonium, chloride, major cations, and H+ (pH) at over 250 locations, and ammonia gas concentrations at 100 sites to estimate dry deposition (through gravitational settling). These measurements are made weekly/biweekly and with standard methods at all sites, and principally for research purposes.

Our data is provided in weekly measurements, monthly, seasonally, and annual averages, is quality assured, and is all available free of charge (see https://nadp.slh.wisc.edu/). This data is used for research, policy decisions and education (primary to graduate). Agricultural scientists use our data in many different types of research; a few examples include understanding chemical movement (nitrogen, other) associated with fertilizers and animal feeding operations, basic data for many agricultural models to understand new techniques and estimate environmental impacts, for evaluating ammonia emission impacts on non-agriculture environments, trends determination over time, etc. Many other nonagricultural scientists use our data as well. Our results are used in approximately 200 journal articles per year, meeting the NRSP research support role.

Finally, NRSP-3 funding is highly leveraged with other federal, state, and tribal agencies, and other groups to provide this national scale data for all scientific purposes and research.

Statement of Issues and Justification

Prerequisite Criteria

How is the NRSP consistent with the mission?

National Research Support Project-3 (the National Atmospheric Deposition Program, or NADP provides a national and international monitoring cooperative to measure the flow of air pollutants into all managed agricultural systems and all other environments over the United States and Canada. Through this cooperation, a research database of pollutant concentration measurements in precipitation and downward fluxes has been developed (since 1978 and at 251 current sites), which supports significant and important agricultural research in several specific areas (collection, assemble, storage, distribution, information, etc.). This cooperative approach directly supports the NRSP mission, by providing basic chemical measurements of sulfur, nitrogen, chloride, and other cations into agricultural systems for researchers to use. All of these compounds are or could be important in many agricultural settings, so the NRSP-3 thereby supports a wide array of agricultural research activities in any number of ways (e.g., Grand Challenges, see below) and supports many other types of environmentally-connected research simultaneously.

NRSP-3 provides a collaborative framework for participating scientists from State Agricultural Experiment Stations (SAES); universities; federal, state, local, and tribal government agencies; national forests and laboratories; environmental institutes; private companies; and other research organizations who cooperate in sponsoring NADP measurement networks. We support the NRSP mission by providing agriculturally-related data that can be used at any and all SAES, any land-grant university (1862, 1890, 1994), and allows for SAES/agricultural scientists to cooperate more easily with researchers from different departments, colleges, universities, and government institutions. Finally, this data is provided to researchers free of charge.

The NADP provides the only regional and national-scale data and information on the amounts, geographic distribution, and trends in chemical deposition by precipitation in North America. The NADP operates five networks which support differing research goals and areas of interest. For this proposal, the agricultural community primarily cooperates in two large networks: the National Trends Network (NTN) and the Ammonia Monitoring Network (AMoN). Specifically, the NTN provides weekly concentrations in precipitation of free acidity (H^+ as pH and concentration of this ion), specific conduc tance, nitrate (NO_3^-), ammonium (NH_4^+), sulfate (SO_4^{2-}), calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+), potassium (K^+), and chloride (Cl^-). The AMoN provides two-week atmospheric concentrations of ammonia gas (NH_3). These compounds are important for agricultural research and therefore can be used in any number of research areas and projects, as is shown year in and year out in our output statistics and project results.

The NRSP-3 research database of these two networks (NTN, AMoN) now includes over 600,000 measurements of precipitation chemistry, extending from 1978 to mid-2023. Each of these records has an observation of each previously listed chemical component, the amount of precipitation for the week, a valid or invalid measurement determination, and a date and time of the measurement, all for over approximately 300 monitoring locations. Finally, the 53 SAES-associated stations have the longest continuing records since most of these sites were the original NRSP-3 sites in the network. Almost all these sites have 40+ year historical records.

Distribution of NRSP-3 data is through a web-accessible database, where **all** scientists and data users have access to all data available, meaning no data or information is sequestered. It is a truly publicly available database for anyone to use (research, education, or policy, see https://nadp.slh.wisc.edu/).

The NRSP-3 has demonstrated flexibility and response to the current and future national needs of the research community for information over a broad array of scientific topics. These topics include the effects of atmospheric deposition on terrestrial and aquatic ecosystems, biogeochemical cycling, climate change, and human health. NRSP-3 data support informed decisions on air quality issues related to precipitation chemistry and atmospheric deposition. NRSP-3 also directly supports the Grand Challenges of the *Science Roadmap for Food and Agriculture*(1), and particularly Grand Challenge 1, 2, 3 and 6, and partially 4 and 5. In general, NRSP-3 information has been invaluable in:

- Documenting the presence and removal of inorganic pollutant gases and aerosols in the atmosphere (i.e., the United States' "chemical climate");
- Documenting how atmospheric chemicals are changing in amount and relative composition over time (trends determination);
- Understanding the effects of atmospherically-deposited chemicals on agricultural crops, national and state and private forests, rangelands, surface and ground waters, estuaries, aquatic impoundments, and other natural resources;
- Documenting the flow of agricultural nitrogen, evaluating new agricultural methods to control the release of nitrogen from cultivated fields and crops into waterways and the atmosphere, tracing gaseous ammonia emissions and movement from agricultural operations, satellite-based tracking of NH_3 in the atmosphere from source to sink, and used in many other agricultural modeling efforts;
- Assessing the accelerated weathering of material and cultural resources resulting from atmospheric chemical deposition;
- Discerning pollutant sources and source distributions and their relationships to deposition (i.e., source-receptor relationships); and
- Evaluating the effectiveness of current Clean Air Act (CAA) legislation and subsequent rules promulgated under the act, and the impact of atmospheric deposition on water quality requirements set by the Clean Water Act.

How does the NRSP pertain as a national issue?

Rationale

Priority Established by ESCOP/ESS

NRSP-3 directly supports the Grand Challenges of the*Science Roadmap for Food and Agriculture*(1), and specifically Grand Challenge 1, 2, 3 and 6. NRPS-3 also supports Challenges 4 and 5.

Grand Challenge 1 "*We must enhance the sustainability, competitiveness, and profitability of U.S. foodand agricultural systems."*

The NRSP-3 directly supports to sustainability and profitability of the U.S. food and agricultural system. This support is provided by:

- NADP supports sustainably of the food system, through the monitoring of pollutants that are emitted from agricultural operations, and therefore promoting efficiency and reduction of environmental damage. One specific pollutant here is nitrogen pollution, and specifically ammonium, ammonia and organic nitrogen (this next year). We measure these compounds in both precipitation and as atmospheric gases, as detailed in many research activities pursued by agricultural scientists. Pollution of the surrounding environment is not a sustainable process, and agricultural scientists are studying new methods to control these emissions. NRSP-3 can monitor for the current emissions, and current observations can be used to monitor emissions over time to determine when the issue is becoming more sustainable (fewer impacts).
- NADP has a role in the monitoring of N loss from animal feeding operations and waste facilities (ammonia, organic nitrogen), and tracking the impact upon the surrounding environment.
- NADP supports competitiveness and profitability through an increase in nitrogen use efficiency and less loses of nitrogen to the environment.
- NADP also monitors for some of the phosphorus compounds, heavily used in agricultural operations (fertilizers), by measuring the growing amount of P in the atmosphere and in deposition, leading to research designed to reduce the presence of phosphorus.

Grand Challenge 2 "*We must adapt to and mitigate the impacts of climate change on food, feed, fiber, and fuel systems in the United States."*

- NRSP-3 monitors climate and climate change by monitoring precipitation at approximately 300 sites across the U.S. Therefore, we monitor one of the principal factors of climate change (e.g., precipitation changes).
- As precipitation changes occur, the "chemical climatology" will likely change. Concentration of pollutants is a direct result of the volume of precipitation, and changes in precipitation (volume) will result in chemical concentrations in the atmosphere. The same is true for deposition rates, which are based on the amount of precipitation that falls. If precipitation depth changes, then deposition rates also will change.
- The above two changes will result in a change in chemical flow to the agricultural lands of the U.S., and NRSP-3 is in place to measure any differences that can be attributed to changes in precipitation.
- Many atmospheric chemistry reactions are temperature dependent (e.g., nitrogen compounds). Many scientists expect higher levels of ozone in the atmosphere, which could accelerate the deposition of the resulting pollutants. NADP measures some of the resulting compounds from ozone reactions.
- With expected increasing temperatures, more cooling will be needed (in U.S. and abroad), and in much of the world, the electricity demand will be met with increasing combustion of coal/natural gas (i.e. India, China). Coal contains many of the pollutants that we measure (e.g., S, N, mercury), and with increasing cooling, a result should be an increase in the deposition of these pollutants. NRSP-3 will be used to track these changes.
- Wildfires and prescribed burns are expected to continue to increase under warming/drier climate scenarios. The NADP's long-term data record can be used to assess the impacts from smoke, biomass burning, carbon cycling, and other disturbances on air quality and agricultural systems.

Grand Challenge 3 "*We must support energy security and the development of the bioeconomy fromrenewable natural resources in the United States."*

- By tracking the movement of S and N compounds, we are documenting the change in atmospheric chemistry and deposition to lands, as the evolution of increasing energy production and electrical needs move from coal based (high S content) to natural gas (low S content) and biofuels.
- As biofuel research and production begins, this will include combustion of compounds within the biofuels (S, N, P, etc.), and any changes in the wet deposition from these activities will be monitored and recorded by the NRSP-3.
- As biofuel production begins, this will require adaption of agricultural procedures and these adaptations could have impacts upon deposition to surrounding environments. The NRSP-3 will be in place to measure any increases or *decreases* of these impacts.
- With the increased electrification of the transportation fleet, more power will be needed. These transportation emissions will be transferred from urban corridors (vehicles) to rural locations where the production of electricity is generated from biofuels. If any change and movement of these pollutants should occur, NRSP-3 will record that signal, providing required information for agricultural researchers looking for impacts from these changes.

Grand Challenge 4 "*We must play a global leadership role to ensure a safe, secure, and abundant foodsupply for the United States and the world."*

Work done in the past has shown the movement of agricultural diseases through the atmosphere. If these diseases are water soluble, the NRSP-3 can be used to show their movement, as we did with Asian Soybean Rust spores. NRSP-3 could be used to monitor movement of any number of biological bodies, spores, etc. In the past, we have proposed to use the assets of the NRSP-3 as an airborne crop disease monitoring network. The NRSP-3 is a network for observation network (infrastructure, sampling media, site operators), and the right scientific techniques allows this observational data to be used for many different agricultural applications.

Additionally, the NADP data could be used to monitor the increased use of fertilizer and herbicides/pesticides, which are all likely to be required with increasing food needs. Herbicides/pesticides have been found in precipitation, and NADP could be used for this type of network (given other quality assurance considerations) with scientific support from our members.

An open agriculturally related network also will allow for easy applications of these types of approaches with the scientists of the SAES system.

Grand Challenge 6 "*We must heighten environmental stewardship through the development of sustainablemanagement practices."*

It seems rather obvious for Challenge 6 that almost every research article using our data are focusing on this Grand Challenge. This is true for the overwhelming majority of the approximately 1000 articles have used NRSP-3 data in their research over the past five years (see https://nadp.slh.wisc.edu/pubs/Annual-Data-Summaries/). It is the case that all the articles mentioned in this proposal supports this Grand Challenge.

Other Challenges Addressed: This listing of grand challenges addressed by NRSP-3 does not discuss the issue of mercury contamination of the soils and fish or the impact to the health of the nation. The three NRSP-3 networks concerned with the movement of mercury (Mercury Deposition Network, Atmospheric Mercury Network, Mercury Litterfall Network)do provide meaningful research data direction to address the Science Roadmap Grand Challenges 4 and 5, concerning health of the national food supply (e.g., mercury moving into the food chain of fish). Fish are principally harvested, but aqua culture is increasing in importance. Fish consumption is important to many subpopulations, particularly coastal states, and native American subsistence populations.

Overall, one of the principal advantages of the NRSP-3, is that it is a science-based observation network. With its structure, scientific direction, and site locations around North America, the NRSP-3 can be used to make many fundamental measurements in a wide variety of ways to measure the temporal and geographical impacts of both chemical and biological effects in support of agricultural research. It is structured for agricultural scientists to make these needs known and to test these ideas out relatively quickly through the NRSP designation.

Relevance to Stakeholders

NRSP-3 provides a collaborative environment to leverage the fiscal, material, human, and intellectual resources of scientists, educators, and policymakers from SAES, universities, government agencies, and non-governmental organizations. Stakeholders include:

- Sponsors that pay for NADP site costs, site operations, etc.
- Site operators contributing efforts in sample collection.
- Cooperators that provide land, electricity, laboratory/office space, and shipping.
- Scientists who use and present NADP data.
- Educators who use NADP data in their classrooms or textbooks.
- Students who use NADP data in the classroom or graduate studies.
- Policy makers who use NADP data to make informed policy decisions.

All program stakeholders are invited to attend twice-yearly subcommittee meetings in the spring and fall, (~ 75 individuals). Subcommittees receive status and progress reports on network activities, review operations and documents, consider procedure and equipment changes, and propose new initiatives. Many stakeholders are officers and ad hoc members of the committees and subcommittees. The NADP *Quality Management Plan* calls for triennial network laboratory reviews, with reviewers drawn from stakeholders.

The Executive Committee (EC) seeks to engage stakeholders in NADP activities. Recent interest has led to investigation of using the NADP to support citizen science, development of the Total N and P measurements, and the breadth of mapping by the Critical Loads (CLAD) subcommittee.

Since 2011, the Total Deposition subcommittee (TDEP) has developed a new map series of total deposition of N and S through a measurement and modeling "fusion". TDEP has been vigorously updating their mapping series and continues to bring in new membership (see reference 37 and https://nadp.slh.wisc.edu/committees/tdep/).

In the last several years, Aero-allergens (pollen) have been stirring interest among several cooperators and a new scientific AMSC subcommittee was established (https://nadp.slh.wisc.edu/committees/amsc/). AMSC has brought in new members primarily from the health community, with intention of using NADP networks as a national atmospheric pollen monitoring network. This effort has made significant progress (38) with the possible use of new technologies in a network. This effort is of interest to many agricultural researchers, since there is a connection between pollen and agriculture.

Stakeholders in the research community can submit a simple proposal to use archived NADP samples for additional research. Researchers are encouraged to attend NADP meetings and present their findings. This has sparked new discussion and new research. Recent research studies include:

- Applying O^{18} and H^{2} measurements to examine the relationship between precipitation and surface and ground water sources. (39-41)
- Using N^{15} measurements to infer atmospheric NO_x sources. (42)
- Testing for the presence of potentially hazardous chemicals. (43-46)
- Investigating organic nitrogen inputs to total deposition.
- Measuring dissolved Si to understand loads to surface waters in the Midwest.

Stakeholder use of NADP data is assessed by recording website activity, requesting annual participant reports, and performing regular literature searches. This information is summarized in SAES-422 and USDA AD-421 reports.

Internet disbursement of precipitation chemistry and atmospheric data is the primary route of NRSP-3 data and information. From 2018-2022, NADP estimated over 20,000 measurement data sets were downloaded each year, and approximately 50,000 PDF map images and 100,000 map data sets (grid and kmz). As far as we know, downloads continue to occur at roughly the same rate over the last five years, suggesting that NRSP-3 remains relevant.

Each year, NRSP-3 summarizes research that develops in whole or in part from NADP data. During the last three years, publication counts have remained high relative to historic counts (since 2007) at about 220 per year. However, 2022 was rather low (183), which may be due to COVID-19 implications. Assuming 2022 was unusual, research use in publications remains consistent, and, again, signals that the NRSP-3 data remains useful and relevant for research support.

NADP data are frequently used to inform and evaluate environmental policies and agreements. NADP maps are utilized in US EPA materials for acid rain deposition and educational materials (https://www.epa.gov/acidrain), and total deposition values mapped by EPA's CASTNET (https://www.epa.gov/power-sector/progress-report-acid-deposition), and annual reports (47). Federal land management agencies also use this data for decisions involving regional haze, critical load estimates, general conservation, climate change decisions, and management of timber resources. NAPAP reports to Congress used NRSP data in assessing emissions changes on deposition on aquatic and terrestrial systems (48). The International Joint Commission uses NADP data in its periodic evaluations of the U.S.-Canada Air Quality Agreement (49) and the Canadian government's deposition assessments (50). Additional regional and state policy assessments, environmental impact statements, and numerous other reports use our data as well (https://nadp.slh.wisc.edu/pubs/nadp-bibliography/).

Each year, articles with agriculture importance are detailed in the NADP's SAES 422/NIFA REEport. Here are three examples from 2021 and 2022:

1. Zhang, J., Cao, & Lu, 2021. Half Century History of Crop Nitrogen Budget in the Conterminous United States: Variations Over Time, Space and Crop Types. Global Biogeo. Cycles 35(10): e2020GB006876.

Crop nitrogen budgets are important to agricultural research, and the authors used multiple datasets to examine N budgets for eight major crops in the U.S. at county scale between 1970 and 2019. The authors concluded that N use efficiency has

increased from 0.55 kg N/kg N in the 1970s to 0.65 kg N/kg N in the 2010s. Corn, rice, cotton, and sorghum have increased in efficiency, while barley, durum wheat, spring wheat, and winter wheat have decreased. Iowa State University researchers used 16 years of national NTN nitrogen deposition data to estimate total N deposition for every county in the U.S.

2. Bhattarai, A., Steinbeck, Grant, Kalcic, King, Smith, Xu, Deng, and Khanal, 2022. Development of a calibration approach using DNDC and PEST for improving estimates of management impacts on water and nutrient dynamics in an agricultural system. Env. Mod. & Software 157: 105494.

The authors (Ohio State, ARS) focused on a modeling study of the biogeochemical DeNitrification DeComposition (DNDC) model in an agriculture situation in Ohio. The goal was to test three model calibrations to determine which was best. They also tested the effectiveness of the PEST parameter estimation software. Several model parameters were shown to be very influential, while corn yield was most sensitive to accumulative temperature and grain carbon to nitrogen ratio. The researchers used repeated years (2014-2020) of NADP's weekly data from a NE Ohio site (IN41).

3. Waiker, P., Ulus, Tsui, and Rueppell, 2022. Mercury accumulation in honey bees trends upward with urbanization in the USA. Ag. & Env. Letters 7(2): e20083.

With this very interesting idea, the authors theorized and found that honeybee (Apis mellifera) mercury concentrations, in part, were explained by the urbanization of the landscape. In their small sample, they did find that honeybee concentrations tend to increase with urbanization, although the low sample numbers. Methyl mercury (organic Hg form) was undetectable in the samples. The authors conclude that "urbanization may play a role in increasing Hg exposure to these pollinators", and honeybees could be a useful biomonitor for pollutants. The authors used seven NADP Mercury Deposition Network sites to associated mercury deposition to the concentrations in bees.

It is important to note that as of the last three months, we have started to build a new database system that will allow for searches of all of the publications that have used NADP data. This is complete for the 2022 year (https://nadp.slh.wisc.edu/pubs/bibliography_search/), and over the next several months we will collect and add the previous years starting in 2007, and will add the 2023 publications after the year's end.

Of special note is the particularly important role that SAES and off-the-top funding plays in NADP. The SAES funding provides three very important advantages:

(1) it enhances the ability of the SAES to address pressing needs of agriculture,

(2) it controls NADP site loss due to lower costs for SAES participation, and

(3) it leverages SAES funding by allowing participation of other federal and state agencies.

All NADP sites pay a management fee for operations. The SAES funding pays some of this fee for the SAES sites (evenly divided, essentially applying a "discount" to each site). The remaining costs are borne by the individual SAES. With a loss of NRSP status, the operational costs at all sites would increase significantly and many sites located in the agricultural production areas could potentially be shut down.

Implementation

Objectives

1. Characterize geographic patterns and temporal trends in chemical or biological atmospheric (wet and dry) deposition
2. Support research activities related to: (a) the productivity of managed and natural ecosystems; (b) the chemistry of surface and ground waters, including estuaries; (c) critical loads in terrestrial and aquatic ecosystems; (d) the health and safety of the nation's food supply; and (e) source-receptor relationships
3. Support education and outreach through the development of informational materials and programs aimed at people of all ages.

Projected Outcomes

- NADP provides timely deliverables of data free of charge. Stakeholders are encouraged to access data from the NADP website (http://nadp.slh.wisc.edu/). Comments: This site offers on-line retrieval of individual data points, seasonal and annual averages, trend plots, concentration and deposition maps, reports, manuals, educational brochures, and other information about NRSP-3. Quality-assured data and information from all networks are loaded quarterly into the on-line database system with a lag of ~180 days. Information available from this website and linked database management system constitute the deliverables that support the project objectives. NADP addresses special request data products, answers scientific questions, and assists users to find related information. Complementing the on-line data and information are publications such as annual data summaries, annual meeting proceedings and presentations, quality assurance documents (e.g., QMP), manuals, informational and educational brochures, and reports. All publications are available online (http://nadp.slh.wisc.edu/lib).
- To assess the type and amount of research activity supported by NRSP-3, participants are asked to annually report their program activities and publications that use NADP data. Comments: Additionally, information is obtained from online literature repositories to locate all publications that reference or use NADP data, maps, and other information. These are summarized annual and provided on the NADP website (http://nadp.slh.wisc.edu/lib/bibliography.aspx), providing for a testable deliverable. More than ~95% of these publications are peer-reviewed journal articles and reports, and also includes masters and PhD theses and dissertations covering a vast range of research areas. The balance includes informational pieces, such as newspaper reports. Over the last three total years (2020-2022), publications listed have numbered 217, 223, and 183 publications, respectively. This demonstrates that NRSP-3 is achieving the primary goals of NRSPs, namely, to support research (and NADP's Objective #2).
- Program Improvements and advancements Comments: Objective (1) was changed during the 2002-06 funding period to "chemical or biological atmospheric (wet and dry) deposition". This objective now explicitly mentions wet and dry deposition, including the (biological) deposition of plant pathogens and pollen. Current networks measure air concentrations of ammonia and mercury make possible the estimation of dry deposition fluxes and builds new research support capacity. Research activities under objective (2) were amended to address emerging interest in critical loads and the health and safety of the nation's food supply (mercury). During this period, a large part of the network changes have been towards monitoring for more N compounds (agricultural needs), and Black Carbon in precipitation (understanding trends and spatial distribution of pollutants from wildfires, relating NADP directly to climate) and PFAS compounds (discussed elsewhere). In summary, a focus of providing more data with the same activities/measurements increases the value of the network. We feel that we have met all our goals for the current period and the previous year, and that all of our data was in place on time and used for research in many different agricultural areas. We can always make better use of our assets and will strive to continue to improve.

Management, Budget and Business Plan

Project Management and Business Plan: Project management of NRSP-3 is described in the *National Atmospheric Deposition Program Governance Handbook* (https://nadp.slh.wisc.edu/pubs/brochures/). This handbook defines the roles and responsibilities of the Executive Committee, the Program Office, and all committees and subcommittees. Each role is briefly summarized in the following sections.

The NADP Program Office (PO), located at the Wisconsin State Laboratory of Hygiene (WSLH) at the UW-Madison, is responsible for promoting long-term NADP operations that comply with the operational procedures and quality-assurance standards set by the Executive Committee (EC), with guidance from its subcommittees. The PO manages day-to-day network operations. The PO responsibilities include:

1. Securing site support, chemical analytical, and data validation services for NADP measurement programs.
2. Ensuring measurement programs produce consistent quality-assured data.
3. Managing the NADP databases and website.
4. Publishing annual map summaries, data reports and other miscellaneous documents.
5. Providing support for committee and subcommittee meetings.
6. Coordinating any special studies.

The NADP Coordinator is the PO Director and works in parallel with the principal investigator of the cooperative agreements between NADP sponsors and the UW-Madison. At least three times per year, the Coordinator reports to the EC on the status and progress of PO and NADP activities.

Budgeting is on a federal fiscal year basis. The Coordinator reports on the fiscal status of the project to the Budget Advisory Committee (BAC), which is responsible for financial planning. The BAC reviews the Coordinator's report and the Coordinator's income and expenditure plans for the upcoming fiscal year. The BAC makes its budget recommendations to the EC, which has budget approval authority. BAC membership consists of elected and ex-officio members and includes the USDA-NIFA representative. The WSLH develops an annual budget that is reviewed and approved by the WSLH Board of Directors, applying a high degree of oversight on the program. As part of the review, the NADP PO develops a balanced budget based on projected income and expenditures and a detailed cost analysis. This approved budget is then presented to the BAC. The budget is continually reviewed by PO and laboratory mangers to ensure operations remain within the approved budget.

The Executive Committee (EC) is responsible for making policy decisions, budgetary decisions and ensuring program continuity and balance for NRSP-3. It provides technical and administrative guidance to the PO. The EC receives input and recommendations from the BAC on budgetary matters and the Quality Assurance Advisory Group on quality assurance matters. It receives input and recommendations from two standing technical subcommittees:

- The Network Operations Subcommittee (NOS), which oversees field-siting criteria and laboratory and sample collection protocols, and evaluates equipment and recordkeeping methods.
- The Education Outreach Subcommittee (EOS), which provides input on data user needs, and develops educational materials and programs or products to promote and increase participation.

The EC acts on recommendations and sets program policies and procedures. EC membership consists of four elected officers, the elected chairs of each of the technical subcommittee, the BAC co-chair, and a SAES representative, all of whom have voting privileges. Membership also includes ex-officio non-voting members, such as the SAES Regional Administrative Advisors, the NIFA program manager and the science committees. Membership in NADP is open and members may participate on any subcommittee or ad hoc group. Summaries of EC minutes, technical subcommittees, and science committees are provided on the web (https://nadp.slh.wisc.edu/committees/).

The EC continues to look for ways to engage new participation in its technical subcommittees, science committees, and annual meetings. In recent years, EC has added several science committees, who focus on scientific topics (critical loads (CLAD), total deposition (TDEP), mercury (MELD), aeroallergens (AMSC), urban monitoring (CitiDep)). Over the years, the focus has primarily been sulfur and nitrogen (see https://nadp.slh.wisc.edu/committees/tdep/), and is a good example of how more information (dry deposition estimates) of S and N, leverages for the benefit of agricultural researchers.

Linking multiple funding sources

The NRSP-3 project has had multiple sources of funding, since the beginning of its operation, and at least since the 1980s. Currently, the NRSP-3 is directly funded by approximately 100 agencies and groups, and funding is ~ $3 million per year. Included in these agencies is the SAES (1.6% of total budget), seven federal agencies (~56%), approximately 30 state agencies (~35%), and miscellaneous universities, local, and tribal government agencies, environmental institutes, private companies and other research organizations (~5%). In FY23, there are 103 organizations that cooperatively fund the NRSP-3. All this money is leveraged from the original decision of the SAES station research idea, multiple long-term commitment of all organizations, and the designation of a national research support project. The key our success and longevity is truly the NRSP designation.

The base funding provided by the OTT MRF funding is extremely important to this project. Beyond the base funding for SAES stations (used to pay some of the management fees), this funding confers the national research support designation. This NRSP designation allows for direct support by the USDA-NIFA. NIFA then allows for federal and state agencies to cooperate with it in the project, which is the key to our multi-funder set up and long-term success.

There are no plans to change our multidisciplinary funding mechanism, and our commitment to allow all organizations to join with us in future funding.

Contributions by SAES

As mentioned previously, the SAESs operate, and have operated our longest operating monitoring stations with the NTN. Of our current 260 NTN sites, 54 of these are either sponsored or operated by SAESs, and located at land-grant universities (see a new interactive map here https://www.google.com/maps/d/u/0/viewer?mid=1-1YiEFtbqAjIg_Pqf_TS7jZ2vyyXPyU&ll=40.105997047819784%2C-83.332170156088O7&z=5). These agricultural sites are located in all four SAES regions, with 41 of 54 sites having a 40+ year operating records.

Along with basic financial support, it is worth noting that these SAES sites provide operators and, in almost all cases, pay the salaries of these operators. They provide electricity and site locations, weekly maintenance of the samplers, mailing services, and management (there is an operator and a supervisor usually located at the SAES.

Agricultural research scientists use our data every year, and these research publications are specifically highlighted annually in our NRSP reporting with the SAES and USDA systems (NMISS and REEport). Additionally, the SAES Administrative Advisors have been long-term supporters and active members of the management of the program. Since about 2007, Dr. Buhler has been a very active member of our meetings (Spring, Budget, Fall). Dr. Payne has been active, particularly during our move (2017/2018) from the University of Illinois to the University of Wisconsin Madison. Drs. White and Xia are relatively new but have already started to participate (midterm review). Dr. G. Hopper/Mississippi State was a particularly good advisor, but he has since retired.

The long-term SAES Community Representative (Dr. Richard Grant/Purdue University) has been an active member of the NRSP-3 for many years, and has been present at almost all meetings and been an officer of the EC twice.

Additionally, we have the support of the SAES here at UW-Madison. I understand they were active and agreeable to the project move from the University of Illinois, supportive of our sites in the SAES system and state, and supportive of the administrative functions (financial) with the OTT funds. We have a good working relationship with the Soils and Forage Analysis Laboratory of the SAES system at UW Madison.

A summary for capacity and modest requested support for the NRSP-3, is as follows:

- NRSP-3 continues to support nationally important areas of research, addressing multiple Grand Challenges, and other areas of important research.
- Each year, numerous agricultural research journal articles are listed, as a specific and concrete example of the SAES mission for national research support projects.
- We provide a monitoring network useful to all agricultural regions, many SAES sites, and open to all agricultural research establishments.
- We have highly leveraged SAES funding ($50,000) to $3.0 million per year through its 100 direct support collaborators.
- We make basic measurements that can be used in a myriad of research areas and have a 40+ year record of consistent and valid monitoring.
- Given our active and widespread availability of people and monitoring ability, we have the capacity to grow to meet any current need or future unseen need, with proposals made by all agricultural scientists.

Project Budget: NRSP-3 provides the authority and framework for combining the resources of many diverse sponsors in support of NRSP-3. Project support is divided into monies administered by the UW-Madison Research and Sponsored Programs (RSP) and the monies and in-kind support for operating NADP site subscribers. Cooperative funds administered by RSP provide the resources for the PO to perform duties and obligations required to satisfy the six responsibilities listed above. Subscriber support site operations including cost of sample collection, transportation and electricity to run the site, sample shipping, and land access and office space. Support for site operations is not administered by WSLH but is provided through an agreement described in the “NADP Shared Services and Responsibilities” document.

Three funding streams provide support for the PO: (1) SAES off-the-top monies, (2) a cooperative agreement between the USDA-NIFA and UW-Madison RSP, and (3) agreements between individual SAES, universities, government agencies, or non-governmental organizations and the WSLH. The USDA-NIFA/ UW-Madison RSP cooperative agreement combines the support of six federal agencies (BLM, NOAA, NPS, USDA-Forest Service, USGS, and ARS), along with USDA, each having an interagency agreement with the USDA-NIFA. Each individual (type 3) agreement funds one or more sites.

Hatch funds provide off-the-top support and the land-grant university support of SAES sites. Since these funds can pay only direct program costs and under the NRSP-3 are combined with funds from other sources, all PO support, no matter the source, pays only direct program costs. Indeed, the USDA-NIFA/UI cooperative agreement stipulates that monies be used only for direct costs and not for facilities and services. Total FY22 support from these three funding streams was $2.91 million. From FY19 to FY24, off-the-top support remained constant at $50,000. Therefore, over the years, SAES funds have been highly leveraged into an internationally successful NRSP.

NRSP-3 off-the-top monies provide partial support of the Program Coordinator. Since this position spearheads day-to-day outreach to new stakeholders and development of innovative data products that support new research interests, we propose a level NRSP-3 budget of $50,000 per year for the FY24-FY28 renewal period.

The NRSP-3 funding model has enabled project growth and diversification of funding sources (see previous section). The NTN is currently at ~260 sites (very stable over the last 15 years). For the network to maintain its size and potentially grow the program, it must contain costs and gain efficiencies in network operations. All funding support leads to reduce per site fees, thus encouraging additional involvement in NADP. With the addition of the AMoN ammonia network, site numbers have increased rapidly to approximately 100 sites, including three sites operated by SAES scientists (AR, CO). Many of the sites are federal sites, with support from US EPA and the National Park Service, again showing leveraging of SAES support to other agencies with support SAES national priorities.

With the addition of the MDN (mercury deposition) in 1996, the number of individual (type 3) agreements has risen to current 85 sites. MDN support comes largely from state, local, and tribal government agencies in states confronting a growing number of health advisories because of mercury-contaminated fish. PO outreach efforts have been successful in enlisting new MDN support from these agencies. MDN is currently at 85 sites, most in the U.S., several in Canada (six sites), and within Tribal Nations (22 sites). This network effort supports the Grand Challenge 1, 4, and 5 (food sources, although not always agriculturally derived).

The NRSP-3 committees and PO continue to look for ways the project can serve regional and national needs. Partnering with USDA-ARS to use NADP samples for detecting ASR spores in precipitation was a very good use of the networks in the past. Initiating the AMON has demonstrated the viability of cost-efficient passive sampling methods for measuring ambient ammonia and is responding to the national need to better understand ammonia sources, atmospheric cycling, and deposition. This is a good agricultural use of the networks. This network shows a strong potential for future growth. Several other potential uses of the networks and agriculture have been identified in other section of this report.

These and other efforts remain true to the vision that NRSP-3/NADP will remain one of the nation's premier research support projects, serving science and education, and supporting informed decisions on air quality issues.

The requested project budgets and specific budget narrative are in the appendix of this report.

Integration

Academic Programs: Data and information on the NADP website have become an important resource for educators at virtually every level. Users indicate that approaching 50% access on the site for educational purposes and the balance for research from academic institutions, with significant growth since the early 2000s (38% education). In 2017 (the most recent assessment, UI), total data downloads were identified as follows: 40% from federal and state agencies, 36% from universities, 16% from K-to-12 schools, and 6% from other individuals or organizations. We expect that these percentages are about the same, given their consistency over the years. These traditional tracking values have not been available at UW Madison. However, our new effort in the next 12 months (google analytics, mentioned previously) should give us a deeper insight into this type of tracking.

NADP data have been used for approximately 10-15 theses/dissertations each year. Over the last 10 years, authors have used NADP data, figures, and maps in undergraduate textbooks in biology, chemistry, environmental sciences, and related areas (54, 55). There are even used occasionally undergraduate honors theses (51). The NADP willingly supplies high quality graphics and data free of charge for these efforts. Secondary-level students continue to access on-line brochures, data and maps for use in science fair projects and classroom exercises.

NADP staff has been involved in extension work with Native American organizations concerning primarily mercury, motivated by the high tribal levels of fish consumption. NADP continues to contribute to the Institute of Tribal Environmental Professionals, National Tribal Air Association, and Tribal Air Monitoring Support Center. Additionally, over the last several years, NRSP-3 has worked within a project with U.S. EPA to further tribal monitoring within their own lands, including further NADP monitoring. Currently, the NRSP-3 cooperates with 22 separate Native American tribes/sites who operate at least one network site in one network, while several run multiple networks.

Past and Ongoing Partnerships:

- The NADP partnership with the ARS Cereal Disease Laboratory at the University of Minnesota to quantify SBR in precipitation samples continued through 2011. This project was previously described in the National Relevance section.
- During 2010 to 2012, the NADP has adopted the PRISM (Parameter-elevation Regressions on Independent Slopes Model) method for developing deposition map products. PRISM data sets, based at Oregon State University, are recognized as being of very high-quality and are supported by the USDA Natural Resources Conservation Service, USDA Forest Service, and the NOAA Office of Global Programs.

Current Partnerships:

- The NRSP-3 collaborated with numerous external monitoring and research organizations including a partnership with the 2015 Acid Rain conference (New York State), and most recently with the 2022 Acid Rain conference, held is Niigata Japan. This meeting was in cooperation with the EANet Program (NRSP-3 like in Asia), and the Japan Ministry of Environment.
- The NRSP-3 is working directly on QA intercomparisons with the National Ecological Observatory Network (NEON) on improving mercury deposition measurements for both networks and comparability between the networks. NEON representatives have recently attended several NADP fall meetings.
- The AMON and AMNet were developed at the request of stakeholders to address the needs of the agricultural research community. In both cases, these newer networks have brought in new site and funding partners, and new researchers. AMON is of particular interest to SAES scientists (discussed elsewhere in this report).
- Cooperation with Mexico: The NRSP-3 is working directly with Dr. Rodolfo Sosa/National Autonomous University of Mexico (Mexico City), to help the Country of Mexico develop a similar NTN-like network for Mexico. The idea is currently at the proposal stage with much work left to do. But our goal is to help get the network operating on a status equivalent to NTN, making intercomparison of data directly possible. In the last two semesters, two graduate students have come to the U.S. to study our methods, which seem to have been valuable. More will be reported here in later annual reports.
- Other cooperative projects have been described earlier, including the new Aeroallergens subcommittee and cooperation with health professionals, the Total N and P sampling, working with the National Park Service, and SAES scientist Dr. J. Collett at Colorado State University, etc.

Support Nationwide Research: NADP data users are in every state and data is actively downloaded by international researchers. The NADP is in the majority of U.S. states and in Canada, Puerto Rico, and the Virgin Islands, and we collaborate with nations including Mexico, Japan, China, South Korea, and Taiwan. The AMON has 100 sites in 39 states and Canada (including all four SAES regions), with preliminary gaseous ammonia measurements extending back to 2007 and official network measurements beginning in 2010. The number of active data users and monitoring sites provide indications of the breadth of support and continued interest in NRSP-3, and recognition that NADP is responsive to emerging needs of researchers and policymakers. The breadth of reports and journal articles using or citing NADP data demonstrates the nationwide, indeed international, use of NADP data.

Outreach, Communications and Assessment

Audience: The NRSP-3 mission is to provide quality-assured data and information on atmospheric deposition for use by scientists, educators, students, policymakers, and the public. **The NRSP-3/NADP has effectively supported outreach and routinely assesses the impact of these activities through quantifiable metrics.**

The NADP website provides on-line access to virtually all project data and information, including educational and informational brochures. All data from all networks is freely available to all interested users through the website (https://nadp.slh.wisc.edu/). This includes the 500,000+ samples for precipitation chemistry and wet deposition collected thus far over all regions of the U.S. and now Canada.

Download web statistics have been presented previously. User statistics show the continual growth in the number of registered users and data downloads, two indicators of the importance and relevance of the data.

In its role of assessing project performance, the NRSP-3 Executive Committee charged the PO with updating the website to improve the organizational layout, facilitate data and map accessibility, enhance communications, and modernize the “look and feel”. NADP has received beneficial feedback through its EOS as to best structure the materials to meet the needs of stakeholders. The second webpage update was completed in early 2023 and available. The website includes sections featuring:

- Education, with new materials for classrooms at the 4th to 6th grade and senior high level.
- News section, where NADP can highlight new happenings with the network, and all current subjects get added to the website quickly.
- Committees section, where mission statements and topics of discussion, minutes, and related materials are located.
- Publications section, including all NADP standard operating procedures, minutes, and presentations from meetings, etc.).
- Operators section, which is new in the last year is a section specifically for all site operators, including standard operating procedures, tools for uploading field data, training videos (new to the project), and a section for starting new sites.

Engagement of Stakeholders: Stakeholders are involved in committee and subcommittee activities, and twice yearly meetings as previously described. In addition, members participate in triennial laboratory and quality management reviews, where they provide recommendations for improvement. Committees and subcommittees identify emerging scientific needs and interests, where all stakeholders are welcome. For example, the AMoN, AMNet, and the new Aeroallergens subcommittees originated with committee discussions. As mentioned in “Management, Budget, and Business Plan,” the committees continually seek increase participation from land-grant university scientists, especially at annual technical meetings.

NADP actively supports engagement with stakeholders, for example at the 2019 Fall Science Symposium and Meeting, NADP through direction of its federal partners is hosted a NADP TDep Workshop "Connecting Stakeholder and Science Perspectives to Better Understand the Linkages Between Agriculture and Reactive Nitrogen Deposition". These special meeting workshops have been held in the past, including one recently on agricultural ammonium. For Spring 2024 (April 29), the TDEP subcommittee is planning for a workshop. Details will be available online with the meeting schedule.

Measuring Accomplishments: Methods to measure program outputs, accomplishments, and impacts have been described in previous sections of the proposal and include:

1. An annual request to all program participants to send a list of accomplishments and publications utilizing NADP data to the PO.
2. Routine searches of scholarly repositories, journal articles, and professional reports.
3. Compilations of web user statistics.
4. Identification of NADP data use in policy-related documents and websites, e.g., NAPAP reports, NRC reviews, government agency reports and websites.
5. Participation in NADP meetings.
6. Routine program reviews.

Many of these have been discussed in other parts of this proposal.

Communication Pieces: The NADP's principal data product is its annual map summary report, which provides a summary of annual highlights and map products. This summary is distributed at scientific meetings and is mailed to all program participants. This year (2023), a new feature is a digital document meant to be read online in a "reading format" (see https://heyzine.com/flip-book/796fbdb6dc.html). This is designed to make it more available to younger scientists who, effectively use electronic documents. Additional publications are available on the NADP website and in print form:

1. ***Welcome to NADP***, which describes the program to "newcomers", encourages their involvement, and is regularly updated with upcoming meeting dates.
2. ***Nitrogen From the Atmosphere****, which is a redesign and rewrite of* ***Nitrogen in the Nation's Rain*** (early 2000s document), with a focus on the gaseous constituents, how nitrogen actually gets into precipitation, and an additional focus on dry deposition of nitrogen along with wet deposition;
3. ***Critical Loads: Evaluating the Effects of Airborne Pollutants on Terrestrial and Aquatic Ecosystems,***where this brochure outlines the function of NADP's Critical Loads Scientific Subcommittee, outlining their products (mapping of critical loads for forests primarily for N, etc.);
4. An updated ***Ammonia Monitoring Network (AMoN) Fact Sheet,*** which describes issues related to gaseous ammonia, and provides an overview of methods and measurements in the AMoN; and
5. ***NADP's Governance Handbook***, providing the structure and operation of NADP's officers, committees, and organization (continually updated), providing a primer for stakeholders, students, and new scientists of the structure and operation of NADP (provided at meetings). This document is updated regularly.

Distribution of Results: As described in previous sections of this proposal, NADP data are distributed primarily via the NADP website, which offers easy-to-use on-line retrieval of data in multiple formats. During 2022, NADP estimated ~20,000 comma-delineated data sets were downloaded, including 14,000 from the NTN database.

In addition, during the next 12 months, with support from UW-Madison computing, NADP would like to add Google Analytics (or similar) to our website. This software is sold as marketing software, but we will use it to give a much deeper insight into who is visiting our website, provide a better understanding of what users are looking for, and very specific counts of what webpages are being read, what is being downloaded, etc. This type of information is very valuable in reporting (as with this report), and for the Education Subcommittee (EOS) to fulfill its goals.

Every year, a scientific symposium is held where presenters summarize the results of their scientific studies that use NADP data. The FY17 through FY23 Fall Scientific Meetings were held in in San Diego CA, Boulder, CO, Knoxville TN, , and Madison WI, and online during the COVID-19 pandemic. A typical Fall Symposium has approximately 150 attendees, and 20-30 students. Since we are an NRSP, it is important to the committees to move the meeting around the country so that new attendees and students living near the meeting will be more likely to attend. All our meetings, with attendees' listings and presentations, can be found here (https://nadp.slh.wisc.edu/conferences/).

Even though COVID-19 presented many difficulties and challenges, it did teach us the advantages of holding online meetings efficiently and developing training that could be accessed anytime. The technical challenges of combining both live and online presenters, making sure everyone could ask questions and be heard, etc. But, we have now learned how to hold these meetings relatively well, and we will continue to hold hybrid meetings. Especially important here is the number of non-North American attendees that were present (China, Japan, Taiwan, Mexico, Peru, various European countries, Canada).

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Outreach Plan

Audience: The NRSP-3 mission is to provide quality-assured data and information on atmospheric deposition for use by scientists, educators, students, policymakers, and the public. **The NRSP-3/NADP has effectively supported outreach and routinely assesses the impact of these activities through quantifiable metrics.**

The NADP website provides on-line access to virtually all project data and information, including educational and informational brochures. All data from all networks is freely available to all interested users through the website (https://nadp.slh.wisc.edu/). This includes the 500,000+ samples for precipitation chemistry and wet deposition collected thus far over all regions of the U.S. and now Canada.

Download web statistics have been presented previously. User statistics show the continual growth in the number of registered users and data downloads, two indicators of the importance and relevance of the data.

In its role of assessing project performance, the NRSP-3 Executive Committee charged the PO with updating the website to improve the organizational layout, facilitate data and map accessibility, enhance communications, and modernize the “look and feel”. NADP has received beneficial feedback through its EOS as to best structure the materials to meet the needs of stakeholders. The second webpage update was completed in early 2023 and available. The website includes sections featuring:

- Education, with new materials for classrooms at the 4th to 6th grade and senior high level.
- News section, where NADP can highlight new happenings with the network, and all current subjects get added to the website quickly.
- Committees section, where mission statements and topics of discussion, minutes, and related materials are located.
- Publications section, including all NADP standard operating procedures, minutes, and presentations from meetings, etc.).
- Operators section, which is new in the last year is a section specifically for all site operators, including standard operating procedures, tools for uploading field data, training videos (new to the project), and a section for starting new sites.

Engagement of Stakeholders: Stakeholders are involved in committee and subcommittee activities, and twice yearly meetings as previously described. In addition, members participate in triennial laboratory and quality management reviews, where they provide recommendations for improvement. Committees and subcommittees identify emerging scientific needs and interests, where all stakeholders are welcome. For example, the AMoN, AMNet, and the new Aeroallergens subcommittees originated with committee discussions. As mentioned in “Management, Budget, and Business Plan,” the committees continually seek increase participation from land-grant university scientists, especially at annual technical meetings.

NADP actively supports engagement with stakeholders, for example at the 2019 Fall Science Symposium and Meeting, NADP through direction of its federal partners is hosted a NADP TDep Workshop "Connecting Stakeholder and Science Perspectives to Better Understand the Linkages Between Agriculture and Reactive Nitrogen Deposition". These special meeting workshops have been held in the past, including one recently on agricultural ammonium. For Spring 2024 (April 29), the TDEP subcommittee is planning for a workshop. Details will be available online with the meeting schedule.

Measuring Accomplishments: Methods to measure program outputs, accomplishments, and impacts have been described in previous sections of the proposal and include:

1. An annual request to all program participants to send a list of accomplishments and publications utilizing NADP data to the PO.
2. Routine searches of scholarly repositories, journal articles, and professional reports.
3. Compilations of web user statistics.
4. Identification of NADP data use in policy-related documents and websites, e.g., NAPAP reports, NRC reviews, government agency reports and websites.
5. Participation in NADP meetings.
6. Routine program reviews.

Many of these have been discussed in other parts of this proposal.

Communication Pieces: The NADP's principal data product is its annual map summary report, which provides a summary of annual highlights and map products. This summary is distributed at scientific meetings and is mailed to all program participants. This year (2023), a new feature is a digital document meant to be read online in a "reading format" (see https://heyzine.com/flip-book/796fbdb6dc.html). This is designed to make it more available to younger scientists who, effectively use electronic documents. Additional publications are available on the NADP website and in print form:

1. ***Welcome to NADP***, which describes the program to "newcomers", encourages their involvement, and is regularly updated with upcoming meeting dates.
2. ***Nitrogen From the Atmosphere****, which is a redesign and rewrite of* ***Nitrogen in the Nation's Rain*** (early 2000s document), with a focus on the gaseous constituents, how nitrogen actually gets into precipitation, and an additional focus on dry deposition of nitrogen along with wet deposition;
3. ***Critical Loads: Evaluating the Effects of Airborne Pollutants on Terrestrial and Aquatic Ecosystems,*** where this brochure outlines the function of NADP's Critical Loads Scientific Subcommittee, outlining their products (mapping of critical loads for forests primarily for N, etc.);
4. An updated ***Ammonia Monitoring Network (AMoN) Fact Sheet,*** which describes issues related to gaseous ammonia, and provides an overview of methods and measurements in the AMoN; and
5. ***NADP's Governance Handbook***, providing the structure and operation of NADP's officers, committees, and organization (continually updated), providing a primer for stakeholders, students, and new scientists of the structure and operation of NADP (provided at meetings). This document is updated regularly.

Distribution of Results: As described in previous sections of this proposal, NADP data are distributed primarily via the NADP website, which offers easy-to-use on-line retrieval of data in multiple formats. During 2022, NADP estimated ~20,000 comma-delineated data sets were downloaded, including 14,000 from the NTN database.

In addition, during the next 12 months, with support from UW-Madison computing, NADP would like to add Google Analytics (or similar) to our website. This software is sold as marketing software, but we will use it to give a much deeper insight into who is visiting our website, provide a better understanding of what users are looking for, and very specific counts of what webpages are being read, what is being downloaded, etc. This type of information is very valuable in reporting (as with this report), and for the Education Subcommittee (EOS) to fulfill its goals.

Every year, a scientific symposium is held where presenters summarize the results of their scientific studies that use NADP data. The FY17 through FY23 Fall Scientific Meetings were held in in San Diego CA, Boulder, CO, Knoxville TN, , and Madison WI, and online during the COVID-19 pandemic. A typical Fall Symposium has approximately 150 attendees, and 20-30 students. Since we are an NRSP, it is important to the committees to move the meeting around the country so that new attendees and students living near the meeting will be more likely to attend. All our meetings, with attendees' listings and presentations, can be found here (https://nadp.slh.wisc.edu/conferences/).

Even though COVID-19 presented many difficulties and challenges, it did teach us the advantages of holding online meetings efficiently and developing training that could be accessed anytime. The technical challenges of combining both live and online presenters, making sure everyone could ask questions and be heard, etc. But, we have now learned how to hold these meetings relatively well, and we will continue to hold hybrid meetings. Especially important here is the number of non-North American attendees that were present (China, Japan, Taiwan, Mexico, Peru, various European countries, Canada).

Organization/Governance

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Land Grant Participating States/Institutions

NY,CA,UT,WI,CO,MN

Non Land Grant Participating States/Institutions

Participation

Participant	Is Head	Station	Objective	Research						Extension	
				KA	SOI	FOS	SY	PY	TY	FTE	KA
Anastasio, Cort		California -Davis : University of California, Davis	1	141	410	2000	0.20	0.00	0.00	0	0
Collett, Jeff	Yes	Colorado - Colorado State University	1,2,3	141 112 133	410 499 499	2000 2070 2000	0.10	0.30	0.00	0	0
DeGaetano, Arthur T.		New York -Ithaca : Cornell University	1,2,3	141 112	499 210	2000 2000	0.10	0.00	0.10	0	0
Gay, David A	Yes	Wisconsin - University of Wisconsin	1,2,3	133 133	199 210	2000 2000	1.00	0.00	0.00	0	0
Gillies, Robert R	Yes	Utah - Utah State University	1	141	410	2070	0.10	0.00	0.00	0	0
Griffis, Timothy	Yes	Minnesota - University of Minnesota	1	141	499	2070	0.10	0.00	0.00	0	0

Combined Participation

Combination of KA, SOI and FOS	Total SY	Total PY	Total TY
112-210-2000	0.05	0	0.1
141-499-2000	0.05	0	0.1
141-410-2000	0.2	0	0
141-410-2070	0.1	0	0
133-199-2000	0.5	0	0
133-210-2000	0.5	0	0
112-499-2070	0.03	0.3	0
133-499-2000	0.03	0.3	0
141-410-2000	0.03	0.3	0
141-499-2070	0.1	0	0
Grand Total:	**1.60**	**0.30**	**0.10**

Program/KA	Total FTE
0	0
0	0
0	0
0	0
0	0
0	0
Grand FTE Total:	**0**

Budgets

MRF Funding 2024

Description	Dollars	FTE
Salaries	37600.00	1.00
Fringe Benefits	12400.00	0.00
Wages	0.00	0.00
Travel	0.00	0.00
Supplies	0.00	0.00
Maintenance	0.00	0.00
Equipment / Capital Improvement	0.00	0.00
Other	0.00	0.00
Totals	**50000**	**1**

Comments

MRF Funding 2025

Description	Dollars	FTE
Salaries	37600.00	1.00
Fringe Benefits	12400.00	0.00
Wages	0.00	0.00
Travel	0.00	0.00
Supplies	0.00	0.00
Maintenance	0.00	0.00
Equipment / Capital Improvement	0.00	0.00
Other	0.00	0.00
Totals	**50000**	**1**

Comments

MRF Funding 2026

Description	Dollars	FTE
Salaries	37600.00	1.00
Fringe Benefits	12400.00	0.00
Wages	0.00	0.00
Travel	0.00	0.00
Supplies	0.00	0.00
Maintenance	0.00	0.00
Equipment / Capital Improvement	0.00	0.00
Other	0.00	0.00
Totals	**50000**	**1**

Comments

MRF Funding 2027

Description	Dollars	FTE
Salaries	37600.00	1.00
Fringe Benefits	12400.00	0.00
Wages	0.00	0.00
Travel	0.00	0.00
Supplies	0.00	0.00
Maintenance	0.00	0.00
Equipment / Capital Improvement	0.00	0.00
Other	0.00	0.00
Totals	**50000**	**1**

Comments

MRF Funding 2028

Description	Dollars	FTE
Salaries	37600.00	1.00
Fringe Benefits	12400.00	0.00
Wages	0.00	0.00
Travel	0.00	0.00
Supplies	0.00	0.00
Maintenance	0.00	0.00
Equipment / Capital Improvement	0.00	0.00
Other	0.00	0.00
Totals	**50000**	**1**

Comments

NE_TEMP2439: Improving the health span of aging adults through diet and physical activity

Status: Submitted As Final

Duration	10/01/2024 to 09/30/2029
Admin Advisors:	[Ingrid E Lofgren]
NIFA Reps:	

Non-Technical Summary

Aging adults face numerous barriers to achieving optimal health and wellness, including chronic diseases, nutritional risk, food insecurity and functional impairments[1, 2, 3]. The United States (U.S.) population is experiencing a shift in demographics. Adults aged 65 years and older have become the largest growing age group. In 2020, about 1 in 6 Americans classified as an older adult, with about 16.8% (55.8 million) aged 65 years and older[4]. There is also a steady increase in older adults identifying as persons of color. The number of persons of color aged 65 years and older increased by 8.2% from 2010 to 2020, making up 23.4% of the population aged 65 and over[4]. The population age 65 and older is projected to be 21.6% of the population by 2040[5].

As the aging adult population continues to grow, a better understanding of effective strategies aimed toward improving the health span is needed. Aging is a multifaceted area of study that is continually exploring how to promote health and well-being throughout the lifespan. An integrative, interdisciplinary approach toward healthy aging from the metabolic level to translational science is imperative as aging is influenced by our genetics, metabolic processes, environment, and lifestyle practices. In doing so, we will likely improve the health span (part of a person's life during which they are generally in good health) of aging adults.

Based on the demographics described above, nutrition, physical activity, and biomarker research for aging adults must include a diverse sample of the US population. A multistate approach is one strategy in which to achieve this.

Statement of Issues and Justification

Factors affecting aging, as indicated by stakeholders

Socioeconomic status. Poverty affects many older adults. In 2020, 8.9% of older adults were living below the poverty level, which increased to 10.3% in 2021 per the Official Poverty Measure [6]. Of this proportion of older adults living below the poverty line, people of color had higher percentages of poverty. Among Black, Asian, and Hispanic populations, the poverty rates were roughly 18%, 9.3%, 17.1% compared to 6.8% among White, not Hispanic[6]. Compared to men, older women are also more likely to be classified as living in a state of poverty in almost all racial/ethnic groups with 10.3% vs. 7.7% in White, 19.1% vs. 16% in Black, 14.9% vs. 11.2% in Asian, 19.8% vs. 17.3% in Hispanic[7]. Limited income adversely affects the nutrition intake of older adults[8].

Food and nutrition insecurity. Food insecurity and hunger can have profound impacts on nutritional status and health-related quality of life (QOL). Although food insecurity and hunger are often used interchangeably, the two are different degrees of the same indicators. Food insecurity is characterized by having inconsistent access and uncertainty in obtaining food, putting individuals at higher risk for malnutrition, chronic disease, and low QOL 24. The threat of food insecurity and hunger among older adults is rapidly increasing with about 15.8%[9] being food insecure and 14.7% facing the threat of hunger [10]. Older adults at greatest risk include those with a low income, those under the age of 70 years, being a person of color, and residing in the southern states [10]. Food insecurity is correlated with lower energy and nutrient intakes, poor health outcomes, increased risk of early mortality and increased health care expenditures [11, 12, 10]. Food insecurity and hunger affect more aging women than aging men [10]. In addition, food insecurity is associated with higher likelihood of having limitations performing activities of daily living (ADLs) [13]. Older adults who were facing the threat of hunger are 30% more likely to report at least one ADL limitation[10]. In turn, due to food-related physical functional limitations such as food purchase and food preparation, the risk of food insecurity is increased. While food security is about economic and physical access to a certain quantity of food, nutrition security considers food quality. This concept is currently being developed.

The USDA NE-1939 Multistate Project “Changing the Health Trajectory for Older Adults through Effective Diet and Activity Modifications” team has conducted various studies to examine the determinants and outcomes of food security. In addition, the USDA Food Security tool was enhanced by developing, testing and validating a physical function food security tool to assess the full extent of food security among older adults attributed not only to economic causes but to physical function limitations as well. Further work is ongoing to examine the quality of the diet of individuals who are food insecure due to economic and physical functional limitations.

Nutritional Risk. Nutritional risk increases with age. This is due to a variety of factors such as decreased appetite, chewing and swallowing difficulties, physical limitations, limited income, reduced social interaction, and chronic diseases. Nutritional risk encompasses both ends of the health spectrum, undernutrition and overnutrition, each with equally detrimental health consequences. The prevalence of malnutrition among older adults is problematic. A nutrient-poor diet is related to morbidity and mortality, physical impairments, functional disability and a greater frequency of admittance to hospitals and other long-term care facilities [14]. The USDA NE-1939 Multistate Project "Changing the Health Trajectory for Older Adults through Effective Diet and Activity Modifications" team has conducted various studies examining the dietary practices of older adults. A three-state study revealed that 80.1% of older adults electing to take part in community nutrition programs were classified as "at nutritional risk" or "at possible nutritional risk" [15]. Poor diets can have a profound effect on cell physiology altering inflammatory markers and oxidative stress, which contribute to telomere erosion and cellular senescence. Our work demonstrates the need for better understanding of the bidirectional relationships between the nutritional status of aging and the impact of nutritional status on health outcomes. An interdisciplinary approach would enable researchers to examine these issues at the cellular, individual and societal levels.

Dietary Intakes. A primary factor affecting the nutritional status of older adults is inadequate food and nutrient intakes. MyPlate recommendations suggest adults over age 50 years consume 1½ to 2 cups of fruits, 2 to 2½ cups of vegetables, 5 to 6 ounce-equivalents of grains, 5 to 5½ ounce-equivalents of protein and 3 cups of dairy daily [16]. However, based on the Healthy Eating Index, only 18% of adults age 60+ years meet grain recommendations, 32% meet recommendations for vegetables, 34% meet total fat recommendations and between 23-27% consume the recommended amount of meat, dairy and fruit [17]. Inadequate food intakes and aging can affect micronutrient status. For example, it is estimated that selenium status in 10% of Americans aged 40 or older is sub-optimal. These levels of marginal deficiency increase the susceptibility to age-related degeneration later in life. High dietary selenium intake has also been reported to increase muscle protein levels by 10-14% in adult pigs[18]. Inversely, whether or not a high protein diet affects body selenium status among aging adults is unknown.

As people age, blood levels of the cardioprotective fatty acid, linoleate (18:2n6) decreases. The decrease in blood levels of linoleic status parallels the loss of skeletal and cardiac muscle function and lean mass[19]. In addition, diminished linoleate status in older individuals coincides with diminished mitochondrial function in skeletal muscle that accompanies aging [20, 21]. Exercise and a balanced diet may prevent muscle atrophy by targeting mitochondria [22].

A dietary intake frequency assessment conducted by the NE-1939 multistate team revealed that the majority of community-residing older adults surveyed were consuming low intake frequencies of protein-rich foods, produce and whole grains [39]. In addition to examining whole food consumption among aging adults, the NE-1939 team is exploring specific nutrients including selenium and fatty acids.

Physical Activity. Physical activity is a key modifiable behavior that can attenuate chronic disease risk and improve physical functioning in older adults [23]. It also builds "physical reserves" so that if physical function declines resulting from illness or injury, individuals with greater physical reserves would be less likely to fall below the threshold for disability [24]. Thus, physical activity is a key component of healthy aging. Unfortunately, the vast majority of older adults are not engaging in the recommended levels of physical activity [23].

Muscular Skeletal Health & Body Composition. Adults can experience a 3 to 8% decline in muscle mass per decade beginning in their 40s and 50s; [25]muscle mass traditionally declines 30% to 50% between the ages of 40 and 80 years [26]. For this project, we use the definition of the Foundation for the National Institutes of Health Sarcopenia Project (FNIH-SP) that uses lean mass (absolute or relative to body mass) and physical function cut points to define sarcopenia [27]. The cut points have been shown to be independent predictors of incident mobility impairment in men and women [28]. Sarcopenia-related health care costs are substantial, with estimates ranging from $11.8 to $26.2 billion 32. A 10% reduction in sarcopenia prevalence could save upward of $1.1 billion annually in the U.S. [29]. Nearly half (46.6%) of these savings would occur if 10% of those with severe sarcopenia were able to improve to a moderate level of sarcopenia while the remaining 56.4% would occur if 10% of those classified with "moderate sarcopenia" moved to "normal" [29]. If sarcopenia were to be eradicated, about 26% of disability cases would be eliminated [29].

Lifestyle practices of older adults, in particular physical inactivity and poor nutritional intake, and weight status (obesity) increase sarcopenia risk [30]. This provides a unique challenge when designing community-based exercise and nutrition programs. An effective sarcopenia prevention/treatment program must increase physical activity and promote healthy eating while preventing an energy deficit that promotes weight loss, which can adversely affect sarcopenia [30]. Establishing successful interventions that preserve and/or improve lean mass and physical function is crucial. There has been a significant effort to determine the most effective and efficacious interventions for treating sarcopenia and its associated symptoms [31]; however, many efforts are not easily transferable to the community setting.

A study conducted as part of the NE-1939 project demonstrated that a 12-week periodized resistance training intervention strategy was effective in retaining appendicular lean muscle mass and improving muscle strength in women ages 65-84 years [32]. The renewal project will further develop this work into a larger-scale, multistate intervention.

Importance of Work

Through our collaborative efforts, we identified community supports for increasing produce consumption among older adults [33] and decreasing nutritional deficiencies that place aging adults at increased sarcopenia risk and nutritional risk in general [15]. For example, we found that dietary selenium insufficiency induces age-related diabetes-like symptoms in association with accelerated telomere shortening [33, 34]. Other dietary interventions, such as fortifying diets with high-quality oils rich in linoleic acid appear to impact skeletal muscle mass [35]. Additionally, we identified exercise modalities that offer promise in lowering sarcopenia risk and severity [32] and that nutritional risk is associated with shorter telomeres, a biological marker of aging [36].

Building on our previous effort, a project renewal will provide the opportunity to expand on the work completed thus far by the members of the USDA NE-1939 Multistate Project "Changing the Health Trajectory for Older Adults through Effective Diet and Activity Modifications" from 2014 to the present. Further work can build on these findings to ascertain if shortened telomeres and the corresponding increase in cellular senescence contribute to sarcopenia.

The renewal project will focus on **three objectives**: (1) to identify biomarkers and molecular mechanisms contributing to healthspan, (2) to conduct multidimensional assessments of food security, nutritional status, physical activity and related factors affecting the aging population, and (3) to develop, implement and evaluate interventions that improve health in aging populations. Given the diversity of the current team, which includes experts from metabolic nutrition to Extension and Outreach researchers, our team is well-positioned to address the health and well-being of community-residing older adults from the laboratory to community. This provides a unique opportunity to work from the metabolic level to translational science.

We will also expand our reach to include those 40 years and older. This expansion of age inclusion is based on our present work that has illustrated the need to start interventions earlier than age 60 when applicable [37, 38, 32.]

The technical feasibility of the research.

Our team has a long-standing interest and a strong research record in the areas of lifestyle risk factors, dietary patterns, nutritional status, exercise/physical activity, physiology and health promotion. Each has extensive experience in one of five areas: metabolic nutrition, epidemiology, nutrition and/or physical activity interventions, qualitative research, nutritional science, and cell physiology. The proposed research is strengthened by our interdisciplinary approach that embodies translational research, taking it from the lab to the community. The project team has a successful work history, including project development, data collection, evaluation, and dissemination.

The advantages for doing the work as a multistate effort.

This multistate aspect will provide the opportunity for team members to reach a diverse group of aging adults from around the United States. The multistate and institutional aspect allows us to collect data from a range of socioeconomic and ethnically diverse populations across rural, suburban and urban geographical areas. This multistate group currently covers the northeast, mid-Atlantic, Southern, and upper Midwest regions of the country. Second, the multistate nature of the project, which entails the utilization of standardized assessment tools used by all researchers, lends itself to establishing a large data set from which additional analyses can be conducted. Additionally, the collaborative nature of the proposed work will allow a better utilization of research funding on larger-scale, multi-purpose, comprehensive projects that embody translational research (lab to community).

Anticipated Impacts

The proposed multistate research team **will train undergraduate and graduate students** in qualitative research (e.g., conducting focus groups, analyzing focus group transcripts), quantitative research (e.g., data collection, data analysis), professional and scientific writing, laboratory skills, anthropometric measures, nutritional status assessment, dietary intake assessment, and physical function. The team will **submit collaborative grant applications** to external funding organizations and **publish research findings** in joint publications. The work conducted through our independent and collaborative efforts will (1) **provide a better understanding of the dietary and physical activity needs** of at-risk aging adults, (2) **develop and implement effective strategies** to address these needs, and (3) **identify biomarkers** related to the health of aging adults. Overall, these combined efforts will improve understanding of dietary intakes, physical function, quality of life (QOL), and food and nutrition security, lower sarcopenia risk, and reduce age-related diseases such as type 2 diabetes.

Related, Current and Previous Work

Related multistate projects. A recent Current Research Information System (CRIS) search of multistate research projects was conducted using the key words: human, aging, nutrition, exercise, physical activity, obesity, and sarcopenia. This search revealed that this proposed renewal project is unique. Other multistate initiatives address some aspects of nutrition, physical activity, exercise, obesity and sarcopenia, but the focus on aging and older adults is not replicated with other multistate projects. Furthermore, there are no known groups working at the intersection of these important topics, with members who represent such a diverse range of disciplines and skills. Continued support of these efforts is perhaps more important than ever before as the population of the US continues to age.

Accomplishments under current project. A strength of the NE-1939: Changing the Health Trajectory for Older Adults through Effective Diet and Activity Modifications multistate project is that the current team is comprised of molecular biologists, nutritional scientists, sociologists, anthropologists, registered dietitian nutritionists, exercise physiologists, and Extension researchers. Having a broad interdisciplinary team provides an opportunity for innovative collaborative translational work. Translational research is key to fundable, comprehensive nutritional research.

Our work since October 2014 has focused on three research areas including molecular and mechanistic understanding of age-related diseases, environmental assessment, and lifestyle needs assessments and interventions. Collectively, we have secured more than $17,119,964 in funding, published 122 peer-reviewed manuscripts (6 joint publications), trained 118 undergraduate students, 118 graduate students, and 27 post-doctoral research associates, and developed various Extension resources, including a four-module Extension healthy aging curriculum (For more information, https://www.nimss.org/meetings/project/18618).

Given the diversity of the work being completed, the resulting projects have been a blend of individual state projects and collaborative multistate efforts. For example, Dr. Belden adapted a PCR-based telomere length assay (a marker for cellular aging) similar to the one used in the NHANES national survey [40]. This initial project involved only Rutgers University (Rutgers) students and faculty. Following this assay adaption, Dr. Ventura-Marra (West Virginia University [WVU]) collaborated with Dr. Belden to perform a telomere assessment as a biological marker of cellular aging as part of a diet and cardiovascular risk assessment study. This collaborative effort provided Dr. Ventura-Marra with the opportunity to report objective data on cellular aging to support the efficacy of a lifestyle intervention and allowed Dr. Belden to use the developed assay in a real-world application [37]. The proposed renewal project is anticipated to expand on this type of collaboration. In addition to their individual foundation experiments, the molecular biologists and nutritional scientists will be involved with select intervention studies to help assess programming impacts by performing comprehensive dietary analyses. Another example is the needs assessment project that was led by Dr. Francis (Iowa State University [ISU]). Dr. Francis worked with NE1939 team members (KUMC, SDSU, UMD, URI, WVU) to 1) assess the nutrition and wellness needs and preferences for adults ages 40 years and older from Iowa, Illinois, South Dakota, Washington DC, West Virginia, Maryland, and Rhode Island; 2) assess the nutrition and physical activity training needs and preferences for health care professionals ages 18 years and older from across the U.S. Additionally, a NIFA, USDA grant application has been submitted with Dr. Weidauer (PD) as the leading institution worked with seven research teams in Arkansas, Iowa, New York, Rhode Island, South Dakota, Washington DC and West Virginia. The project titled “PARTNERSHIP StrengthenHer: Empowering Women through a Community-Based Virtual Sarcopenia Prevention Program” is an effort to develop and implement a community-based, online sarcopenia prevention program over a five-year period across multiple states. There are also several collaborative projects underway, such as Brain Health (lead by Dr. Elgloria Harrison) and Technology and Digital Option for older adults (lead by Dr. Dara LoBuono). These multistate collaborations resulted in ascertaining the priorities for healthy eating in older adults in diverse communities [33] and used the resulting survey tool to determine the perceived environmental supports for produce consumption among older adults [41]. As a result, our team has a better understanding of the produce access issues facing older adults. We learned how to use technology to conduct qualitative research across state lines and now have a tool that can be used by other team members. Further, the inclusion of sociologists and anthropologists on our team in recent years has enabled our environmental and intervention work to look more holistically at the health and well-being of older adults. We anticipate expanding on this work by including more quality-of-life assessment tools during our studies.

Multistate research projects offer many benefits, including working across state lines to evaluate the efficacy and impact of lifestyle interventions among diverse audiences. However, a challenge is that in order for an intervention to be effective it must be focused on the needs and preferences of the target audience. This means the approach utilized by each state may need to differ. To be more collaborative while respecting the unique needs of residents from each state, we began using common assessment tools across studies. This has allowed for the merging of data to perform cross-sectional studies. For example, many states were implementing various community-based nutrition education programs designed to meet the needs of our stakeholders. Although we were not evaluating the same intervention across states, each state had asked the same sociodemographic questions and used the same nutritional risk assessment tool. Team members from three states, New Hampshire (no longer with the project), Rhode Island and Iowa, created a multistate database with sociodemographic data and the nutritional risk assessment data to identify the nutritional risk factors of community-residing older adults. This study revealed most community-residing older adults were at nutritional risk and that their intake frequencies of protein-rich foods was low [15]. Given the success of this project, this approach will be expanded for this proposed renewal project with all states choosing from the same assessment measures as appropriate for their studies.

Furthermore, three current team members are Extension state specialists (ISU, Mississippi State University [MSU], and UICU). Having Extension Specialists on the NE-1939 team, has allowed for the development of community-based materials and interventions based on the formative work completed through the NE-1439 project. For example, the Stay Independent—a healthy aging series (https://www.extension.iastate.edu/humansciences/stay-independent) was developed based on the nutritional risk assessments by MacNab and others [15]. It is now a statewide program in Iowa. For the proposed renewal project, we aim to pilot test community-based interventions through Extension as well as develop Extension publications and products that are informed through our collaborative research efforts. Doing so, increases the likelihood of this multistate project having national implications, as Extension is available in all states.

The work accomplished over the past few years through the NE-1939 multistate project has identified sarcopenia as a focus of our future interdisciplinary work. Helping adults age in place is a critical public health and economic issue as the number of adults turning age 65+ grows rapidly. Long-term care spending reached $210.9 billion in 2011 in the United States (US) [42] and can comprise a major expense for older adults. Sarcopenia is a major threat to the ability to age in place. It is an often undiagnosed, chronic disease affecting older adults, and has dire consequences both financially and physically [29]. The renewal project provides the opportunity for team members to focus on sarcopenia prevention, applying a translational approach that is inclusive of molecular, community and environmental areas. This is innovative in the area of sarcopenia research. While sarcopenia will be a disease endpoint of focus, we will also continue to emphasize the way in which the work we do will have applications for the general aging process and for other health conditions.

Objectives

1. To identify biomarkers and molecular mechanisms contributing to healthspan.
2. To conduct multidimensional assessments of nutrition, physical activity and related factors affecting the aging population.
3. To develop, implement and evaluate interventions that improve health in aging population.

Methods

Team members are expected to participate in at least one of the three overarching research objectives. The interdisciplinary composition of our team necessitates individual-level research as well as integrative, collaborative projects. The proposed activities will contribute toward the long-term goal of promoting the independence and well-being of community-residing aging adults (ages 40 years and older) while enabling researchers to maintain autonomy over their research experiments. For example, many of the laboratory-based projects will take place at the one of three universities (MSU, Ohio State University [OSU], and Rutgers); however, the formative work being completed in the areas of lipidomics (OSU), selenium (MSU) and telomere length (Rutgers, MSU) will inform our intervention strategies. It is also anticipated that some of our lifestyle intervention researchers will work with our molecular biologists and nutritional scientists to conduct specialized laboratory tests in addition to the traditional blood tests when examining the impact of dietary and physical activity programming. Finally, establishing one standardized set of inclusion criteria for human subjects conducted as part of this project is not feasible given the anticipated blend of individual-level and collaborative research as well as target behaviors. Therefore, the recruitment strategies utilized may vary by study (Appendix A). The following are some ongoing and proposed new research activities by objective.

Objective 1: To identify biomarkers and molecular mechanisms contributing to healthspan.

Studies in this area involve performing molecular assessments on aging adults as a means to better inform participants' activities and diet choices. Diet and exercise ultimately affect physiology on the molecular and cellular level and specific biomarkers are often the best predictors of whether certain diet and exercise modifications are beneficial. To accomplish Area 1, routine assessments of telomere length (Leukocyte Telomere Length [LTL] assay) will be coupled with assays that monitor markers of inflammation (CRP, Fibrinogen, IL-6, and TNFg). The purpose of these assays will help predict the best diet and activity interventions for the participants and educate them on best practices to increase health span and independent living. In particular, Wu and others [34], have reported dietary selenium deficiency shortens telomere length in the highly proliferative colonocytes and accelerates incidence of such age-related symptoms of telomere-humanized mice. This provides an opportunity to assess whether telomere length is associated with blood selenium status in aging adults. Muscle mass will be estimated using bioelectrical impedance or skinfold and circumference measurements. Muscle function will be measured using grip strength, a criterion of the FNIH definition of sarcopenia [27] will be used to assess muscle function [43, 44]. Peripheral blood lymphocytes collected at the same time as plasma for markers of inflammation and telomere length (above) will be analyzed for mitochondrial enzyme activity (e.g., citrate synthase activity)[45]. Targeted lipidomics of mitochondrial fractions from peripheral blood lymphocytes will identify mitochondrial phospholipids that are modified by dietary lipids[46].

Objective 2: To conduct multidimensional assessments of nutrition, diet, physical activity and related factors affecting the aging population. These multidimensional assessments will be at the community and individual levels and the findings will be used to inform studies conducted under Objective 3

includes conducting needs assessments on the preferences on the preferences, opinions, beliefs, and attitudes of aging populations' for community environmental supports for secure, culturally appropriate environments for healthy lifestyle. Improving the general health, functionality and the quality of life (QOL) of aging populations is a Healthy People 2030 goal [47, 48]. In order to achieve this, social determinants of health (circumstances in the environment in which people are born, live, learn, work, worship and age) must be considered. The purpose of these studies is to identify the most important and modifiable enablers of healthy eating behaviors among aging adults. To accomplish this, mixed methodology approaches will be used, including both qualitative and quantitative methods such as individual interviews, focus groups and consumer surveys. Qualitative methodology is an effective way to engage groups of people in a conversation about topics in which there are gaps in the literature and results can be useful as formative data to create surveys. Open-ended questions will be used, and questions will be developed to answer gaps in the literature. All individual interviews and focus group discussions will be transcribed verbatim and will be analyzed using standard protocols. Themes will then be identified from the most prevalent codes found amongst the transcriptions. Additional consumer surveys will be developed using literature reviews, formative data from focus group discussions, or from community service providers and/or members in the participating states. These surveys will highlight the most important and modifiable community settings to improve food access and dietary behaviors in older adults. Unvalidated surveys will be pretested for clarity and reliability and then administered to consumers and other community centers serving aging populations in participating states. Surveys will identify aging populations' use of community supports for healthy lifestyle behaviors and provide recommendations for improvement to foster these healthy behaviors. Additionally, analysis will be conducted to examine dietary patterns and coping strategies of food-insecure individuals due to limited social resources and physical functionality using the validated USDA Household Food Security Scale and the Food Security-Physical Function limitations.

Objective 3: To develop, implement, and evaluate interventions that improve health in aging populations. This objective will involve developing theory-based, consumer-informed nutrition and physical activity interventions which can be translated and adopted at the community level to better help aging population improve their overall health and prolong independence. These interventions may focus on a variety of health areas affecting aging adults such as chronic disease prevention, weight management, sarcopenia, arthritis reduction, and food security. For example, expanding on the work completed as part of the NE-1939 project we will further develop a sarcopenia prevention program. The key outcome measures include anthropometric, biochemical, clinical, dietary, physical activity, socioeconomic, and environmental factors. The growth of the current team (13 states) has resulted in a more diverse make-up of states. This diversity includes population density (urban versus rural). Of the 11 states focused on community-based research, four (36.4%) have rural state populations of 20% and higher [49]. Rural-residing older adults have worse physical health, decreased socialization, and a lower health-related quality of life than their urban-residing counterparts do [50, 51]. The proposed renewal project will begin to examine programs' relevance toward both rural and urban environments. The proposed renewal project will also begin to considr clustered important factors linked to evidence-based intervention sustainability including local policy, health care systems, and environment, and examine strategies that could better address those factors in an effort to enhance the identified needs from Objective 2. All of those approaches are attempted to examine and disseminate effective strategies results from varied interventions into practice at varied community settings.

It is the development and testing of a theory-based, community-implemented, exercise and nutrition program (StrengthenHer [Empowering Women through a Multi-State Virtual Sarcopenia Prevention] Program) capable of reducing the risk of and/or severity of sarcopenia among women ages 40-75 years. The long-term goal of the StrengthenHer Program is to promote the independence and well-being of community-residing aging and older women through an integrative, community-based exercise and nutrition intervention. The StrengthenHer program utilizes an interdisciplinary approach, applies sustainable lifestyle intervention approaches, and is designed for community-delivery through Extension. The StrengthenHer Program will include creating an exercise DVD that emphasizes resistance training (based on work completed by URI as part of the NE-1439 project) and a nutrition curriculum that promotes protein intake through whole foods (based on MacNab study [15]). The key indicators may include physical function (grip strength, four-meter gait speed test, chair stand tests, isometric leg extensor strength), body composition (multi-frequency bioelectrical impedance analysis (MFBIA), height and weight), nutrition and food measures (multiple 24-hour recalls, nutritional risk and dietary intake frequencies, complete blood counts, serum selenium levels), and markers of inflammation. The intervention will be pilot-tested in a variety of community settings. Data analysis will be undertaken using general linear models methods, focused on testing for differences between Control and Treatment groups and controlling for relevant demographic and structural covariates. The StrengthenHer program will be implemented across six states (Arkansas, Iowa, New York, Rhode Island, South Dakota, and West Virginia) and one district (Washington DC) in both urban and rural areas.

Survey Tool Descriptions

Sociodemographic Attributes

We will use the demographic questions collected as part of the Performance Outcome Measurement Project (POMP) [52]. The demographics modules include 10 questions related to gender, race, age, marital status. These questions utilize standard wording used with national surveys, which will allow for better comparison to national findings.

Nutritional Risk and Dietary Intake Frequency Assessment:

The Dietary Screening Tool (DST) is a validated tool to assess nutritional risk in middle-aged and older adults based on frequency of intakes of fruits, vegetables, dietary fiber, lean protein, added fat, sugars and sweets, dairy, and processed meats. The DST has 25 food and behavior specific questions, which can be completed by individuals in less than 10 minutes and scored by clinicians in less than 5 minutes [53, 54]. The maximum score of 100 points is divided into 7 diet component categories (added fats, sugar, and sweets; whole fruit and juice; vegetables; total and whole grains; lean protein; dairy; and processed meat). A higher score is desirable as it indicates lower nutritional risk ("nutritional risk" [75 points]) [53]. As part of the NE-1439 project, Dr. Ventura-Marra validated the DST for use among middle-age adults (45 to 64 year olds) [55]; thus expanding its use among all aging adults.

Food Security

Food insecurity is associated with poverty, lower nutrient intakes, increased likelihood of poor or fair health, being a person of color, activities of daily living (ADLs) limitations, and poor chronic disease management [56-62]. Per the USDA Economic Research Service, nearly all the states in the renewal project where community-based research will occur (10 out of 11) has a food insecurity rate of 10% and higher [49]. The renewal project intends to collect food security data. To lower participant burden, researchers will be encouraged to use either the "Six-Item Short Form" [63] or the two-question option [64]. The "Six-Item Short Form" quickly assesses food insecurity among older adults [63]. A two-question subset from this short form has a sensitivity of 96% and higher and a specificity of 79% and higher [64].

Quality of Life (QOL)

We will assess QOL using one of the following tools: Satisfaction with Life Scale (SWLS) [65], food satisfaction will be measured using the Satisfaction with Food-Related Life (SWFL) scale [66], or the deJong Gieveld 6-item loneliness scale [67]. The validated SWLS is a measure of subjective well-being. It is a 5-item 7-point Likert scale questionnaire used as a measure of global cognitive judgments of satisfaction with one's life [65]. The SWFL scale is comprised of five questions on a 6-point Likert scale centered on food and meals [66]. The loneliness scale consists of six questions and assesses emotional loneliness and social loneliness [67].

Physical Activity

The validated Yale Physical Activity Survey (YPAS) estimates caloric expenditure of habitual physical activity, including exercise activities, chores, and leisure activities in older adults [68, 69.] It is valid and reliable when used with adults aged 60-86 years. Since there are no questions regarding specific exercises such as resistance training, we will ask a few additional questions regarding recent engagement in resistance training or other exercises including recent frequency, duration, and intensity.

Physical Function

Physical function will be assessed using at least one of the following tests: static handgrip strength [70-73] the Short Physical Performance Battery Protocol (SPPB) [74, 75] and a 400-meter walk test [76, 77].

Static handgrip strength is a simple, safe, reliable and valid predictor of total body strength, physical functioning, and future disability and will be done using a hand-grip dynamometer (Jaymar Hydraulic Dynamometer, J.A. Preston, Corp., Jackson, MS) [70-73]. Participants will perform the grip strength test in a seated position using their dominant arm with the elbow flexed at a 90-degree angle. They will be instructed using standardized oral encouragement to squeeze the dynamometer with as much force as possible and the highest force attained will be recorded. Three trials separated by a 1-minute rest period will be done and the highest force will be used.

The SPPB includes three balance tests, a gait speed test and a chair stand test [74, 75]. Walking speed will be measured by requesting the participant to walk at their normal pace over a 4m distance. Time in seconds to complete the full course will be recorded. Two attempts will be done, and the faster of the two times will be used. A 46-cm high straight-back chair will be used to complete the repeated chair stand test, and participants will be instructed to stand up from the chair once without using their arms for assistance. If a participant is able to complete one chair stand, he/she will be asked to stand up and sit back down five times as quickly as possible, and the time to complete one series of five chair stands will be recorded. Participants will be instructed to sustain balance in three different positions distinguished by sequential narrowing of the base of support. Position one will begin with feet together (i.e. side by side); position two will consist of the heel of one foot next to the big toe of the other foot (i.e. semi-tandem); the last position will have the heel of one foot in front of and touching the toes of the other foot (i.e. tandem). For all three positions, participants will be timed for a maximum of 10 seconds, and scores will be summed for the measure of balance for a range of 0 to 30 seconds. Scores from 0 (inability to complete the test) to 4 (highest possible score) will be assigned to each of the three performance measures based on standard cut-points. A summary score ranging from 0 (lowest) to 12 (highest) will be calculated by adding walking speed, chair stands, and balance scores.

We will also use the 400-m walk test [76,77]. This test is a predictor of subsequent mortality in older adults. On a track (or measured corridor) each participant will be instructed to walk the track in a continuous loop as quickly as possible at a pace that can be maintained. Standardized oral encouragement will be given, as well as feedback regarding the number of laps remaining.

Measurement of Progress and Results

Outputs

- Development of a Manual of Operations that includes all common validated tools that will be used for multistate research efforts. This manual will help ensure common research protocols are followed by all states.
- A comprehensive database of needs assessment and intervention data will be developed to allow for multistate cross-sectional data analysis and comprehensive assessment of lifestyle inventions for community-residing aging adults.
- Results from these studies will be used to provide recommendations to appropriate agencies regarding implementation of methods to improve availability and accessibility of healthful foods and physical activity for older adults.
- Continued statistical exploration of the associations among the following age-related health factors: dietary and physical activity behaviors, quality of life, socioeconomic status, race, etc.
- Molecular data of telomere length and markers of inflammation correlated with specific dietary and activity interventions.
- Using cross-sectional and longitudinal approaches, we will measure the association of dietary fat quality with changes of muscle function, mass and mitochondrial capacity. Results will be used to design intervention studies to test dietary oils (doses and types) to attend the loss of muscle mass and function in older people.

Outcomes or Projected Impacts

- Improved understanding of the nutrition and physical activity practices of community-residing adults ages 40 years and older influencing their chronic disease status.
- Reduced chronic disease incidence and/or severity as indicated through self-report, validated survey outcomes related to the targeted chronic disease and/or blood values.
- Reduced nutritional risk and improved dietary intake frequencies as measured by the DST among those participating in nutrition-focused interventions
- Increased physical activity participation among aging adults and increased physical function among those attending exercise, physical activity and/or sarcopenia interventions.
- Reduced food insecurity among those with limited incomes
- Enhanced healthspan as assessed by reduced chronic disease risk factors, increased QOL, and/or physical function.
- Study participants will gain knowledge regarding recommended nutrition and physical activity behaviors.
- Optimized healthspan through nutrition and physical activities that are cost-effective and achievable for aging or older adults.
- Study participants will implement dietary and other lifestyle goals that will attenuate muscle loss.

Milestones

(**1**):Develop operations manual for common survey tools. o Develop SPSS-base codebooks for each of the common research tools. o Prepare manuscripts and grant submissions for studies.

(**2**):Create lifeSPAN curriculum and prepare related grant applications. o Optimize laboratory procedures for blood collection and preparation of peripheral blood lymphocytes at multiple sites. o Prepare manuscripts and grant submissions for studies.

(**3**):Pilot-test lifeSPAN program. o Collect survey data from across states. o Examine telomere length and markers of inflammation for selected studies. o Quantify association of dietary fat intake with mitochondrial capacity and muscle health. o Prepare manuscripts and grant submissions for studies.

(**5**):Conduct cross-sectional data analysis using multistate dataset. o Examine telomere length and markers of inflammation for selected studies. o Prepare manuscripts and grant submissions for studies.

Outreach Plan

We plan to disseminate the work accomplished through this multistate project at multiple levels. We will create and distribute education materials and programs for community-level implementation, ideally through Extension but may also include Area Agencies on Aging and public health departments. Joint publications related to our research findings will be prepared and submitted to peer-reviewed journals. We will continue to do oral and poster presentations at local, regional and national professional meetings such as Experimental Biology, American College of Sports Medicine, the American Society for Nutrition annual meeting, Food and Nutrition Conference and Expo, the Society of Nutrition Education and Behavior annual meeting, and the annual National Health Outreach Conference (Extension).

Organization/Governance

Currently an Executive Committee (chair, chair-elect, past-chair, secretary, and member-at-large) and a Regional Administrative Advisor has the administrative oversight and organization for the multistate group. All positions are elected to three-year terms by team members during the annual meeting. The term begins October 1 of each respective year. The Chair is responsible for setting the meetings, developing and posting agendas, and facilitating the meetings. The Chair also oversees the completion of the annual reports and project-related revisions. The chair-elect completes the duties in the absence of the chair. The secretary maintains the minutes and sends to the Chair to post on the multistate website. The member-at-large attends the executive committee meetings and performs other duties as assigned by the Chair. The multi-state members meet on a regular basis (every other month) via online meetings and annually face-to-fact at a date and place that is selected by the entire group.

The NE-1939 Multistate group is in the process of developing and adopting a policy and procedures manual that will guide the functioning of the group. The maximum size of the multistate group will be 25 members. Members will be expected to actively participate in, collaborate, and contribute to the multistate research and administrative activities. Members who choose not to actively participate will be asked to resign from the group. Active participation is defined as participating in at least 50% of online meetings and contributing to the collaborative research and administrative activities. Consideration for termination of group membership due to inactive status will be presented on agenda and discussed by full group membership followed by a vote by the full membership at the next group meeting (face-to-face or online). A protocol will be established for accepting new members. It is anticipated that new members will be voted upon by the current members and should have applicable expertise that strengthens the group research, at least one chapter of dissertation published, and able to obtain independent funding for participation. The best time to join the group will be during the renewal process. Candidates must submit CV and documentation of how their skills meet the group research needs to the Chair. The group will review and vote upon the respective candidates.

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Land Grant Participating States/Institutions

Non Land Grant Participating States/Institutions

Participation

Participant	Is Head	Station	Objective	Research						Extension	
				KA	SOI	FOS	SY	PY	TY	FTE	KA

Combined Participation

Combination of KA, SOI and FOS	Total SY	Total PY	Total TY
Grand Total:	**0**	**0**	**0**

Program/KA	Total FTE
Grand FTE Total:	**0**

NE1939: Improving the health span of aging adults through diet and physical activity.

(Multistate Research Project) **Status: Active**

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Appendix G: Peer Review (Submitted)

Status: Complete

Project ID/Title: NE_TEMP2439: Improving the health span of aging adults through diet and physical activity

Rate the technical merit of the project:

1. Sound Scientific approach:
Approve/continue project
2. Achievable goals/objectives:
Excellent
3. Appropriate scope of activity to accomplish objectives:
Excellent
4. Potential for significant outputs(products) and outcomes and/or impacts:
Excellent
5. Overall technical merit:
Excellent
Comments
This project has many exciting implications for the development and implementation of effective interventions to prevent and reduce sarcopenia among older adults, improve physical function, and improve overall quality of life (and health span). I appreciate the inclusion of adults in their 40's, as previous research shows that interventions need to start earlier in life. I look forward to following what this group finds in their interdisciplinary, collaborative research!
Your Recommendation:
Approve/continue project

Appendix G: Peer Review (Submitted)

Status: Complete

Project ID/Title: NE_TEMP2439: Improving the health span of aging adults through diet and physical activity

Rate the technical merit of the project:

1. Sound Scientific approach:
Approve/continue project
2. Achievable goals/objectives:
Good
3. Appropriate scope of activity to accomplish objectives:
Good
4. Potential for significant outputs(products) and outcomes and/or impacts:
Good
5. Overall technical merit:
Good
Comments
The team has a clear record of success and is comprised of a multidisciplinary team that spans foundational science to human intervention. Strong needs related to the health and well-being of older adults are identified. The opportunities for growth highlighted in the proposal will enhance both a critical body of knowledge and necessary community-based interventions related to sarcopenia and overall health span. The objectives present concise, concrete, and attainable next steps. Further developing then translating the social determinants of health research (objective 2) would be useful (expanding beyond the direct-education proposed in objective 3).
Your Recommendation:
Approve/continue project

Appendix G: Peer Review (Submitted)

Status: Complete

Project ID/Title: NE_TEMP2439: Improving the health span of aging adults through diet and physical activity

Rate the technical merit of the project:

1. Sound Scientific approach:
Approve/continue project
2. Achievable goals/objectives:
Excellent
3. Appropriate scope of activity to accomplish objectives:
Good
4. Potential for significant outputs(products) and outcomes and/or impacts:
Excellent
5. Overall technical merit:
Good
Comments
This project addresses a gap in translational research to promote overall health span in rapidly expanding, diverse older populations. The project objectives and proposed methodologies are sound, feasible, and are to be achievable by the multistate interdisciplinary team with over a decade of successful collaboration and institutional resources. The resulting data and outcomes have the potential to inform future research, program, and policy decisions aimed at improving the overall well-being of older adults.

Considering Policy, Systems, and Environmental (PSE) intervention strategies, complementing the proposed direct intervention (Objective 3) would strengthen the project and reflect the identified needs for community environmental support in promoting health span from the perspectives of older adults (Objective 2). The expansion of the StrengthenHer program (Objective 3) to men and across different race-ethnic groups ages 40-75 years may be needed to meet the overall project goal.
Your Recommendation:
Approve/continue project

Reviewer #1 Comments

Overall Comment: This project addresses a gap in translational research to promote overall health span in rapidly expanding, diverse older populations. The project objectives and proposed methodologies are sound, feasible, and are to be achievable by the multistate interdisciplinary team with over a decade of successful collaboration and institutional resources. The resulting data and outcomes have the potential to inform future research, program, and policy decisions aimed at improving the overall well-being of older adults.

Response: Thank you very much for your insightful review and comments.

Comment 1.1. Considering Policy, Systems, and Environmental (PSE) intervention strategies, complementing the proposed direct intervention (Objective 3) would strengthen the project and reflect the identified needs for community environmental support in promoting health span from the perspectives of older adults (Objective 2).

Response 1.1. Good point. We added statement in Objective 3 to address this comment.

"*The proposed renewal project will also begin to consider clustered important factors linked to evidence-based intervention sustainability including local policy, health care systems and environments, and examine strategies that could better address those factors in an effort to enhance the identified needs from Objective 2."*

Comment 1.2: The expansion of the StrengthenHer program (Objective 3) to men and across different race-ethnic groups ages 40-75 years may be needed to meet the overall project goal.

Response 1.2. Thank you. Although we agree with reviewer that such program is important for both men and women, we do have sound rational why our focuses is on women for example Women are less physically active than men (Stahl & Albert, 2015), the number of women turning age 65+ years grows rapidly (Administration for Community Living, 2020), longer life expectancy and associated health care costs (Ginter, Simok, 2013, Alemayehu & Warner, 2004), the average per person sarcopenia associated cost for women is higher than men (Janssen et al, 2004). Also, compared to men, older women are also more likely to be classified as living in a state of poverty in almost all racial/ethnic groups (Harris, et al., 2013).

- Stahl ST, Albert SM. Gender differences in physical activity patterns among older adults who fall. Prev Med. 2015 Feb;71:94-100. doi: 10.1016/j.ypmed.2014.12.016.
- Administration for Community Living. *2020 Profile of Older Americans*.
- Ginter E, Simko V. Women live longer than men. Bratisl Lek Listy. 2013;114(2):45-49. doi:10.4149/BLL_2013_011
- Alemayehu B, Warner KE. The lifetime distribution of health care costs. Health Serv Res. 2004;39(3):627-642. doi:10.1111/J.1475-6773.2004.00248.X
- Papadopoulou SK. Sarcopenia: A Contemporary Health Problem among Older Adult Populations. Nutrients. 2020;12(5). doi:10.3390/NU12051293
- Janssen I, Shepard DS, Katzmarzyk PT, Roubenoff R. The Healthcare Costs of Sarcopenia in the United States. J Am Geriatr Soc. 2004;52(1):80-85. doi:10.1111/j.1532-5415.2004.52014.x
- Harris WS, Pottala JV, Varvel SA, Borowski JJ, Ward JN, McConnell Prostaglandins. Leukot Essent Fatty Acids. 2013 Apr;88(4):257-63.

Reviewer #2 Comments

Overall Comment: The team has a clear record of success and is comprised of a multidisciplinary team that spans foundational science to human intervention. Strong needs related to the health and well-being of older adults are identified. The opportunities for growth highlighted in the proposal will enhance both a critical body of knowledge and necessary community-based interventions related to sarcopenia and overall health span. The objectives present concise, concrete, and attainable next steps.

Response: Thank you very much for your insightful review and comments.

Comment 2.1. Further developing then translating the social determinants of health research (objective 2) would be useful (expanding beyond the direct-education proposed in objective 3).

Response 2.1. Good point, we revised our objective 3 to address this comment. That is, translation research in practice, especially during the implementation stage. Statements added are

"which can be translated and adopted at the community level to better help aging population improve their overall health and prolong independence"

"All of those approaches are attempted to examine and disseminate effective strategies results from varied interventions into practice at varied community settings."

Reviewer #3 Comments

Overall comment: This project has many exciting implications for the development and implementation of effective interventions to prevent and reduce sarcopenia among older adults, improve physical function, and improve overall quality of life (and health span). I appreciate the inclusion of adults in their 40's, as previous research shows that interventions need to start earlier in life. I look forward to following what this group finds in their interdisciplinary, collaborative research!

Response: Thank you very much for your insightful review and comments. We are glad that you recognize what we also believe are the strengths of our project.

NE_TEMP2439: Improving the health span of aging adults through diet and physical activity.

Duration: 10/01/2024 to 09/30/2029

Administrative Advisor(s): Ingrid E Lofgren

NIFA Reps: Mallory Koenings

Statement of Issues and Justification

Aging adults face numerous barriers to achieving optimal health and wellness, including chronic diseases, nutritional risk, food insecurity and functional impairments[1, 2, 3]. The United States (U.S.) population is experiencing a shift in demographics. Adults aged 65 years and older have become the largest growing age group. In 2020, about 1 in 6 Americans classified as an older adult, with about 16.8% (55.8 million) aged 65 years and older[4]. There is also a steady increase in older adults identifying as persons of color. The number of persons of color aged 65 years and older increased by 8.2% from 2010 to 2020, making up 23.4% of the population aged 65 and over[4]. The population age 65 and older is projected to be 21.6% of the population by 2040[5].

As the aging adult population continues to grow, a better understanding of effective strategies aimed toward improving the health span is needed. Aging is a multifaceted area of study that is continually exploring how to promote health and well-being throughout the lifespan. An integrative, interdisciplinary approach toward healthy aging from the metabolic level to translational science is imperative as aging is influenced by our genetics, metabolic processes, environment, and lifestyle practices. In doing so, we will likely improve the health span (part of a person's life during which they are generally in good health) of aging adults.

Based on the demographics described above, nutrition, physical activity, and biomarker research for aging adults must include a diverse sample of the US population. A multistate approach is one strategy in which to achieve this.

Factors affecting aging, as indicated by stakeholders

Socioeconomic status. Poverty affects many older adults. In 2020, 8.9% of older adults were living below the poverty level, which increased to 10.3% in 2021 per the Official Poverty Measure [6]. Of this proportion of older adults living below the poverty line, people of color had higher percentages of poverty. Among Black, Asian, and Hispanic populations, the poverty rates were roughly 18%, 9.3%, 17.1% compared to 6.8% among White, not Hispanic[6]. Compared to men, older women are also more likely to be classified as living in a state of poverty in almost all racial/ethnic groups with 10.3% vs. 7.7% in White, 19.1% vs. 16% in Black, 14.9% vs. 11.2% in Asian, 19.8% vs. 17.3% in Hispanic[7]. Limited income adversely affects the nutrition intake of older adults[8].

Food and nutrition insecurity. Food insecurity and hunger can have profound impacts on nutritional status and health-related quality of life (QOL). Although food insecurity and hunger are often used interchangeably, the two are different degrees of the same indicators. Food insecurity is characterized by having inconsistent access and uncertainty in obtaining food, putting individuals at higher risk for malnutrition, chronic disease, and low QOL 24. The threat of food insecurity and hunger among older adults is rapidly increasing with about 15.8%[9] being food insecure and 14.7% facing the threat of hunger [10]. Older adults at greatest risk include those with a low income, those under the age of 70 years, being a person of color, and residing in the southern states [10]. Food insecurity is correlated with lower energy and nutrient intakes, poor health outcomes, increased risk of early mortality and increased health care expenditures [11, 12, 10]. Food insecurity and hunger affect more aging women than aging men [10]. In addition, food insecurity is associated with higher likelihood of having limitations performing activities of daily living (ADLs) [13]. Older adults who were facing the threat of hunger are 30% more likely to report at least one ADL limitation[10]. In turn, due to food-related physical functional limitations such as food purchase and food preparation, the risk of food insecurity is increased. While food security is about economic and physical access to a certain quantity of food, nutrition security considers food quality. This concept is currently being developed.

The USDA NE-1939 Multistate Project "Changing the Health Trajectory for Older Adults through Effective Diet and Activity Modifications" team has conducted various studies to examine the determinants and outcomes of food security. In addition, the USDA Food Security tool was enhanced by developing, testing and validating a physical function food security tool to assess the full extent of food security among older adults attributed not only to economic causes but to physical function limitations as well. Further work is ongoing to examine the quality of the diet of individuals who are food insecure due to economic and physical functional limitations.

Nutritional Risk. Nutritional risk increases with age. This is due to a variety of factors such as decreased appetite, chewing and swallowing difficulties, physical limitations, limited income, reduced social interaction, and chronic diseases. Nutritional risk encompasses both ends of the health spectrum, undernutrition and overnutrition, each with equally detrimental health consequences. The prevalence of malnutrition among older adults is problematic. A nutrient-poor diet is related to morbidity and mortality, physical impairments, functional disability and a greater frequency of admittance to hospitals and other long-term care facilities [14]. The USDA NE-1939 Multistate Project "Changing the Health Trajectory for Older Adults through Effective Diet and Activity Modifications" team has conducted various studies examining the dietary practices of older adults. A three-state study revealed that 80.1% of older adults electing to take part in community nutrition programs were classified as "at nutritional risk" or "at possible nutritional risk" [15]. Poor diets can have a profound effect on cell physiology altering inflammatory markers and oxidative stress, which contribute to telomere erosion and cellular senescence. Our work demonstrates the need for better understanding of the bidirectional relationships between the nutritional status of aging and the impact of nutritional status on health outcomes. An interdisciplinary approach would enable researchers to examine these issues at the cellular, individual and societal levels.

Dietary Intakes. A primary factor affecting the nutritional status of older adults is inadequate food and nutrient intakes. MyPlate recommendations suggest adults over age 50 years consume 1½ to 2 cups of fruits, 2 to 2½ cups of vegetables, 5 to 6 ounce-equivalents of grains, 5 to 5½ ounce-equivalents of protein and 3 cups of dairy daily [16]. However, based on the Healthy Eating Index, only 18% of adults age 60+ years meet grain recommendations, 32% meet recommendations for vegetables, 34% meet total fat recommendations and between 23-27% consume the recommended amount of meat, dairy and fruit [17]. Inadequate food intakes and aging can affect micronutrient status. For example, it is estimated that selenium status in 10% of Americans aged 40 or older is sub-optimal. These levels of marginal deficiency increase the susceptibility to age-related degeneration later in life. High dietary selenium intake has also been reported to increase muscle protein levels by 10-14% in adult pigs[18]. Inversely, whether or not a high protein diet affects body selenium status among aging adults is unknown.

As people age, blood levels of the cardioprotective fatty acid, linoleate (18:2n6) decreases. The decrease in blood levels of linoleic status parallels the loss of skeletal and cardiac muscle function and lean mass[19]. In addition, diminished linoleate status in older individuals coincides with diminished mitochondrial function in skeletal muscle that accompanies aging [20, 21]. Exercise and a balanced diet may prevent muscle atrophy by targeting mitochondria [22].

A dietary intake frequency assessment conducted by the NE-1939 multistate team revealed that the majority of community-residing older adults surveyed were consuming low intake frequencies of protein-rich foods, produce and whole grains [39]. In addition to examining whole food consumption among aging adults, the NE-1939 team is exploring specific nutrients including selenium and fatty acids.

Physical Activity. Physical activity is a key modifiable behavior that can attenuate chronic disease risk and improve physical functioning in older adults [23]. It also builds "physical reserves" so that if physical function declines resulting from illness or injury, individuals with greater physical reserves would be less likely to fall below the threshold for disability [24]. Thus, physical activity is a key component of healthy aging. Unfortunately, the vast majority of older adults are not engaging in the recommended levels of physical activity [23].

Muscular Skeletal Health & Body Composition. Adults can experience a 3 to 8% decline in muscle mass per decade beginning in their 40s and 50s; [25]muscle mass traditionally declines 30% to 50% between the ages of 40 and 80 years [26]. For this project, we use the definition of the Foundation for the National Institutes of Health Sarcopenia Project (FNIH-SP) that uses lean mass (absolute or relative to body mass) and physical function cut points to define sarcopenia [27]. The cut points have been shown to be independent predictors of incident mobility impairment in men and women [28]. Sarcopenia-related health care costs are substantial, with estimates ranging from $11.8 to $26.2 billion 32. A 10% reduction in sarcopenia prevalence could save upward of $1.1 billion annually in the U.S. [29]. Nearly half (46.6%) of these savings would occur if 10% of those with severe sarcopenia were able to improve to a moderate level of sarcopenia while the remaining 56.4% would occur if 10% of those classified with "moderate sarcopenia" moved to "normal" [29]. If sarcopenia were to be eradicated, about 26% of disability cases would be eliminated [29].

Lifestyle practices of older adults, in particular physical inactivity and poor nutritional intake, and weight status (obesity) increase sarcopenia risk [30]. This provides a unique challenge when designing community-based exercise and nutrition programs. An effective sarcopenia prevention/treatment program must increase physical activity and promote healthy eating while preventing an energy deficit that promotes weight loss, which can adversely affect sarcopenia [30]. Establishing successful interventions that preserve and/or improve lean mass and physical function is crucial. There has been a significant effort to determine the most effective and efficacious interventions for treating sarcopenia and its associated symptoms [31]; however, many efforts are not easily transferable to the community setting.

A study conducted as part of the NE-1939 project demonstrated that a 12-week periodized resistance training intervention strategy was effective in retaining appendicular lean muscle mass and improving muscle strength in women ages 65-84 years [32]. The renewal project will further develop this work into a larger-scale, multistate intervention.

Importance of Work

Through our collaborative efforts, we identified community supports for increasing produce consumption among older adults [33] and decreasing nutritional deficiencies that place aging adults at increased sarcopenia risk and nutritional risk in general [15]. For example, we found that dietary selenium insufficiency induces age-related diabetes-like symptoms in association with accelerated telomere shortening [33, 34]. Other dietary interventions, such as fortifying diets with high-quality oils rich in linoleic acid appear to impact skeletal muscle mass [35]. Additionally, we identified exercise modalities that offer promise in lowering sarcopenia risk and severity [32] and that nutritional risk is associated with shorter telomeres, a biological marker of aging [36].

Building on our previous effort, a project renewal will provide the opportunity to expand on the work completed thus far by the members of the USDA NE-1939 Multistate Project “Changing the Health Trajectory for Older Adults through Effective Diet and Activity Modifications” from 2014 to the present. Further work can build on these findings to ascertain if shortened telomeres and the corresponding increase in cellular senescence contribute to sarcopenia.

The renewal project will focus on **three objectives**: (1) to identify biomarkers and molecular mechanisms contributing to healthspan, (2) to conduct multidimensional assessments of food security, nutritional status, physical activity and related factors affecting the aging population, and (3) to develop, implement and evaluate interventions that improve health in aging populations. Given the diversity of the current team, which includes experts from metabolic nutrition to Extension and Outreach researchers, our team is well-positioned to address the health and well-being of community-residing older adults from the laboratory to community. This provides a unique opportunity to work from the metabolic level to translational science.

We will also expand our reach to include those 40 years and older. This expansion of age inclusion is based on our present work that has illustrated the need to start interventions earlier than age 60 when applicable [37, 38, 32.]

The technical feasibility of the research.

Our team has a long-standing interest and a strong research record in the areas of lifestyle risk factors, dietary patterns, nutritional status, exercise/physical activity, physiology and health promotion. Each has extensive experience in one of five areas: metabolic nutrition, epidemiology, nutrition and/or physical activity interventions, qualitative research, nutritional science, and cell physiology. The proposed research is strengthened by our interdisciplinary approach that embodies translational research, taking it from the lab to the community. The project team has a successful work history, including project development, data collection, evaluation, and dissemination.

The advantages for doing the work as a multistate effort.

This multistate aspect will provide the opportunity for team members to reach a diverse group of aging adults from around the United States. The multistate and institutional aspect allows us to collect data from a range of socioeconomic and ethnically diverse populations across rural, suburban and urban geographical areas. This multistate group currently covers the northeast, mid-Atlantic, Southern, and upper Midwest regions of the country. Second, the multistate nature of the project, which entails the utilization of standardized assessment tools used by all researchers, lends itself to establishing a large data set from which additional analyses can be conducted. Additionally, the collaborative nature of the proposed work will allow a better utilization of research funding on larger-scale, multi-purpose, comprehensive projects that embody translational research (lab to community).

Anticipated Impacts

The proposed multistate research team **will train undergraduate and graduate students** in qualitative research (e.g., conducting focus groups, analyzing focus group transcripts), quantitative research (e.g., data collection, data analysis), professional and scientific writing, laboratory skills, anthropometric measures, nutritional status assessment, dietary intake assessment, and physical function. The team will **submit collaborative grant applications** to external funding organizations and **publish research findings** in joint publications. The work conducted through our independent and collaborative efforts will (1) **provide a better understanding of the dietary and physical activity needs** of at-risk aging adults, (2) **develop and implement effective strategies** to address these needs, and (3) **identify biomarkers** related to the health of aging adults. Overall, these combined efforts will improve understanding of dietary intakes, physical function, quality of life (QOL), and food and nutrition security, lower sarcopenia risk, and reduce age-related diseases such as type 2 diabetes.

Related, Current and Previous Work

Related multistate projects. A recent Current Research Information System (CRIS) search of multistate research projects was conducted using the key words: human, aging, nutrition, exercise, physical activity, obesity, and sarcopenia. This search revealed that this proposed renewal project is unique. Other multistate initiatives address some aspects of nutrition, physical activity, exercise, obesity and sarcopenia, but the focus on aging and older adults is not replicated with other multistate projects. Furthermore, there are no known groups working at the intersection of these important topics, with members who represent such a diverse range of disciplines and skills. Continued support of these efforts is perhaps more important than ever before as the population of the US continues to age.

Accomplishments under current project. A strength of the NE-1939: Changing the Health Trajectory for Older Adults through Effective Diet and Activity Modifications multistate project is that the current team is comprised of molecular biologists, nutritional scientists, sociologists, anthropologists, registered dietitian nutritionists, exercise physiologists, and Extension researchers. Having a broad interdisciplinary team provides an opportunity for innovative collaborative translational work. Translational research is key to fundable, comprehensive nutritional research.

Our work since October 2014 has focused on three research areas including molecular and mechanistic understanding of age-related diseases, environmental assessment, and lifestyle needs assessments and interventions. Collectively, we have secured more than $17,119,964 in funding, published 122 peer-reviewed manuscripts (6 joint publications), trained 118 undergraduate students, 118 graduate students, and 27 post-doctoral research associates, and developed various Extension resources, including a four-module Extension healthy aging curriculum (For more information, https://www.nimss.org/meetings/project/18618).

Given the diversity of the work being completed, the resulting projects have been a blend of individual state projects and collaborative multistate efforts. For example, Dr. Belden adapted a PCR-based telomere length assay (a marker for cellular aging) similar to the one used in the NHANES national survey [40]. This initial project involved only Rutgers University (Rutgers) students and faculty. Following this assay adaption, Dr. Ventura-Marra (West Virginia University [WVU]) collaborated with Dr. Belden to perform a telomere assessment as a biological marker of cellular aging as part of a diet and cardiovascular risk assessment study. This collaborative effort provided Dr. Ventura-Marra with the opportunity to report objective data on cellular aging to support the efficacy of a lifestyle intervention and allowed Dr. Belden to use the developed assay in a real-world application [37]. The proposed renewal project is anticipated to expand on this type of collaboration. In addition to their individual foundation experiments, the molecular biologists and nutritional scientists will be involved with select intervention studies to help assess programming impacts by performing comprehensive dietary analyses. Another example is the needs assessment project that was led by Dr. Francis (Iowa State University [ISU]). Dr. Francis worked with NE1939 team members (KUMC, SDSU, UMD, URI, WVU) to 1) assess the nutrition and wellness needs and preferences for adults ages 40 years and older from Iowa, Illinois, South Dakota, Washington DC, West Virginia, Maryland, and Rhode Island; 2) assess

the nutrition and physical activity training needs and preferences for health care professionals ages 18 years and older from across the U.S. Additionally, a NIFA, USDA grant application has been submitted with Dr. Weidauer (PD) as the leading institution worked with seven research teams in Arkansas, Iowa, New York, Rhode Island, South Dakota, Washington DC and West Virginia. The project titled "PARTNERSHIP StrengthenHer: Empowering Women through a Community-Based Virtual Sarcopenia Prevention Program" is an effort to develop and implement a community-based, online sarcopenia prevention program over a five-year period across multiple states. There are also several collaborative projects underway, such as Brain Health (lead by Dr. Elgloria Harrison) and Technology and Digital Option for older adults (lead by Dr. Dara LoBuono). These multistate collaborations resulted in ascertaining the priorities for healthy eating in older adults in diverse communities [33] and used the resulting survey tool to determine the perceived environmental supports for produce consumption among older adults [41]. As a result, our team has a better understanding of the produce access issues facing older adults. We learned how to use technology to conduct qualitative research across state lines and now have a tool that can be used by other team members. Further, the inclusion of sociologists and anthropologists on our team in recent years has enabled our environmental and intervention work to look more holistically at the health and well-being of older adults. We anticipate expanding on this work by including more quality-of-life assessment tools during our studies.

Multistate research projects offer many benefits, including working across state lines to evaluate the efficacy and impact of lifestyle interventions among diverse audiences. However, a challenge is that in order for an intervention to be effective it must be focused on the needs and preferences of the target audience. This means the approach utilized by each state may need to differ. To be more collaborative while respecting the unique needs of residents from each state, we began using common assessment tools across studies. This has allowed for the merging of data to perform cross-sectional studies. For example, many states were implementing various community-based nutrition education programs designed to meet the needs of our stakeholders. Although we were not evaluating the same intervention across states, each state had asked the same sociodemographic questions and used the same nutritional risk assessment tool. Team members from three states, New Hampshire (no longer with the project), Rhode Island and Iowa, created a multistate database with sociodemographic data and the nutritional risk assessment data to identify the nutritional risk factors of community-residing older adults. This study revealed most community-residing older adults were at nutritional risk and that their intake frequencies of protein-rich foods was low [15]. Given the success of this project, this approach will be expanded for this proposed renewal project with all states choosing from the same assessment measures as appropriate for their studies.

Furthermore, three current team members are Extension state specialists (ISU, Mississippi State University [MSU], and UICU). Having Extension Specialists on the NE-1939 team, has allowed for the development of community-based materials and interventions based on the formative work completed through the NE-1439 project. For example, the Stay Independent—a healthy aging series (https://www.extension.iastate.edu/humansciences/stay-independent) was developed based on the nutritional risk assessments by MacNab and others [15]. It is now a statewide program in Iowa. For the proposed renewal project, we aim to pilot test community-

based interventions through Extension as well as develop Extension publications and products that are informed through our collaborative research efforts. Doing so, increases the likelihood of this multistate project having national implications, as Extension is available in all states.

The work accomplished over the past few years through the NE-1939 multistate project has identified sarcopenia as a focus of our future interdisciplinary work. Helping adults age in place is a critical public health and economic issue as the number of adults turning age 65+ grows rapidly. Long-term care spending reached $210.9 billion in 2011 in the United States (US) [42] and can comprise a major expense for older adults. Sarcopenia is a major threat to the ability to age in place. It is an often undiagnosed, chronic disease affecting older adults, and has dire consequences both financially and physically [29]. The renewal project provides the opportunity for team members to focus on sarcopenia prevention, applying a translational approach that is inclusive of molecular, community and environmental areas. This is innovative in the area of sarcopenia research. While sarcopenia will be a disease endpoint of focus, we will also continue to emphasize the way in which the work we do will have applications for the general aging process and for other health conditions.

Objectives

1. To identify biomarkers and molecular mechanisms contributing to healthspan.
2. To conduct multidimensional assessments of nutrition, physical activity and related factors affecting the aging population.
3. To develop, implement and evaluate interventions that improve health in aging population.

Methods

Team members are expected to participate in at least one of the three overarching research objectives. The interdisciplinary composition of our team necessitates individual-level research as well as integrative, collaborative projects. The proposed activities will contribute toward the long-term goal of promoting the independence and well-being of community-residing aging adults (ages 40 years and older) while enabling researchers to maintain autonomy over their research experiments. For example, many of the laboratory-based projects will take place at the one of three universities (MSU, Ohio State University [OSU], and Rutgers); however, the formative work being completed in the areas of lipidomics (OSU), selenium (MSU) and telomere length (Rutgers, MSU) will inform our intervention strategies. It is also anticipated that some of our lifestyle intervention researchers will work with our molecular biologists and nutritional scientists to conduct specialized laboratory tests in addition to the traditional blood tests when examining the impact of dietary and physical activity programming. Finally, establishing one standardized set of inclusion criteria for human subjects conducted as part of this project is not feasible given the anticipated blend of individual-level and collaborative research as well as target behaviors. Therefore, the recruitment strategies utilized may vary by study (Appendix A). The following are some ongoing and proposed new research activities by objective.

Objective 1: To identify biomarkers and molecular mechanisms contributing to healthspan.

Studies in this area involve performing molecular assessments on aging adults as a means to better inform participants' activities and diet choices. Diet and exercise ultimately affect physiology on the molecular and cellular level and specific biomarkers are often the best predictors of whether certain diet and exercise modifications are beneficial. To accomplish Area 1, routine assessments of telomere length (Leukocyte Telomere Length [LTL] assay) will be coupled with assays that monitor markers of inflammation (CRP, Fibrinogen, IL-6, and TNFg). The purpose of these assays will help predict the best diet and activity interventions for the participants and educate them on best practices to increase health span and independent living. In particular, Wu and others [34], have reported dietary selenium deficiency shortens telomere length in the highly proliferative colonocytes and accelerates incidence of such age-related symptoms of telomere-humanized mice. This provides an opportunity to assess whether telomere length is associated with blood selenium status in aging adults. Muscle mass will be estimated using bioelectrical impedance or skinfold and circumference measurements. Muscle function will be measured using grip strength, a criterion of the FNIH definition of sarcopenia [27] will be used to assess muscle function [43, 44]. Peripheral blood lymphocytes collected at the same time as plasma for markers of inflammation and telomere length (above) will be analyzed for mitochondrial enzyme activity (e.g., citrate synthase activity)[45]. Targeted lipidomics of mitochondrial fractions from peripheral blood lymphocytes will identify mitochondrial phospholipids that are modified by dietary lipids[46].

Objective 2: To conduct multidimensional assessments of nutrition, diet, physical activity and related factors affecting the aging population. These multidimensional assessments will be at the community and individual levels and the findings will be used to inform studies conducted under Objective 3

includes conducting needs assessments on the preferences on the preferences, opinions, beliefs, and attitudes of aging populations' for community environmental supports for secure, culturally appropriate environments for healthy lifestyle. Improving the general health, functionality and the quality of life (QOL) of aging populations is a Healthy People 2030 goal [47, 48]. In order to achieve this, social determinants of health (circumstances in the environment in which people are born, live, learn, work, worship and age) must be considered. The purpose of these studies is to identify the most important and modifiable enablers of healthy eating behaviors among aging adults. To accomplish this, mixed methodology approaches will be used, including both qualitative and quantitative methods such as individual interviews, focus groups and consumer surveys. Qualitative methodology is an effective way to engage groups of people in a conversation about topics in which there are gaps in the literature and results can be useful as formative data to create surveys. Open-ended questions will be used, and questions will be developed to answer gaps in the literature. All individual interviews and focus group discussions will be transcribed verbatim and will be analyzed using standard protocols. Themes will then be identified from the most prevalent codes found amongst the transcriptions. Additional consumer surveys will be developed using literature reviews, formative data from focus group discussions, or from community service providers and/or members in the

participating states. These surveys will highlight the most important and modifiable community settings to improve food access and dietary behaviors in older adults. Unvalidated surveys will be pretested for clarity and reliability and then administered to consumers and other community centers serving aging populations in participating states. Surveys will identify aging populations' use of community supports for healthy lifestyle behaviors and provide recommendations for improvement to foster these healthy behaviors. Additionally, analysis will be conducted to examine dietary patterns and coping strategies of food-insecure individuals due to limited social resources and physical functionality using the validated USDA Household Food Security Scale and the Food Security-Physical Function limitations.

Objective 3: To develop, implement, and evaluate interventions that improve health in aging populations. This objective will involve developing theory-based, consumer-informed nutrition and physical activity interventions which can be translated and adopted at the community level to better help aging population improve their overall health and prolong independence. These interventions may focus on a variety of health areas affecting aging adults such as chronic disease prevention, weight management, sarcopenia, arthritis reduction, and food security. For example, expanding on the work completed as part of the NE-1939 project we will further develop a sarcopenia prevention program. The key outcome measures include anthropometric, biochemical, clinical, dietary, physical activity, socioeconomic, and environmental factors. The growth of the current team (13 states) has resulted in a more diverse make-up of states. This diversity includes population density (urban versus rural). Of the 11 states focused on community-based research, four (36.4%) have rural state populations of 20% and higher [49]. Rural-residing older adults have worse physical health, decreased socialization, and a lower health-related quality of life than their urban-residing counterparts do [50, 51]. The proposed renewal project will begin to examine programs' relevance toward both rural and urban environments. The proposed renewal project will also begin to consider clustered important factors linked to evidence-based intervention sustainability including local policy, health care systems and environments, and examine strategies that could better address those factors in an effort to enhance the identified needs from Objective 2. All of those approaches are attempted to examine and disseminate effective strategies results from varied interventions into practice at varied community settings.

It is the development and testing of a theory-based, community-implemented, exercise and nutrition program (StrengthenHer [Empowering Women through a Multi-State Virtual Sarcopenia Prevention] Program) capable of reducing the risk of and/or severity of sarcopenia among women ages 40-75 years across different racial/ethnic groups. The long-term goal of the StrengthenHer Program is to promote the independence and well-being of community-residing aging and older women through an integrative, community-based exercise and nutrition intervention. The StrengthenHer program utilizes an interdisciplinary approach, applies sustainable lifestyle intervention approaches, and is designed for community-delivery through Extension. The StrengthenHer Program will include creating an exercise DVD that emphasizes resistance training (based on work completed by URI as part of the NE-1439 project) and a nutrition curriculum that promotes protein intake through whole foods (based on MacNab study [15]). The key indicators may include physical function (grip strength, four-meter gait speed test, chair stand tests, isometric leg extensor strength), body composition (multi-frequency

bioelectrical impedance analysis (MFBIA), height and weight), nutrition and food measures (multiple 24-hour recalls, nutritional risk and dietary intake frequencies, complete blood counts, serum selenium levels), and markers of inflammation. The intervention will be pilot-tested in a variety of community settings. Data analysis will be undertaken using general linear models methods, focused on testing for differences between Control and Treatment groups and controlling for relevant demographic and structural covariates. The StrengthenHer program will be implemented across six states (Arkansas, Iowa, New York, Rhode Island, South Dakota, and West Virginia) and one district (Washington DC) in both urban and rural areas.

Survey Tool Descriptions (*note: common instruments used across different sites thus we don't have to list all the tool used)

Sociodemographic Attributes

We will use the demographic questions collected as part of the Performance Outcome Measurement Project (POMP) [52]. The demographics modules include 10 questions related to gender, race, age, marital status. These questions utilize standard wording used with national surveys, which will allow for better comparison to national findings.

Nutritional Risk and Dietary Intake Frequency Assessment:

The Dietary Screening Tool (DST) is a validated tool to assess nutritional risk in middle-aged and older adults based on frequency of intakes of fruits, vegetables, dietary fiber, lean protein, added fat, sugars and sweets, dairy, and processed meats. The DST has 25 food and behavior specific questions, which can be completed by individuals in less than 10 minutes and scored by clinicians in less than 5 minutes [53, 54]. The maximum score of 100 points is divided into 7 diet component categories (added fats, sugar, and sweets; whole fruit and juice; vegetables; total and whole grains; lean protein; dairy; and processed meat). A higher score is desirable as it indicates lower nutritional risk ("nutritional risk" [75 points]) [53]. As part of the NE-1439 project, Dr. Ventura-Marra validated the DST for use among middle-age adults (45 to 64 year olds) [55]; thus expanding its use among all aging adults.

Food Security

Food insecurity is associated with poverty, lower nutrient intakes, increased likelihood of poor or fair health, being a person of color, activities of daily living (ADLs) limitations, and poor chronic disease management [56-62]. Per the USDA Economic Research Service, nearly all the states in the renewal project where community-based research will occur (10 out of 11) has a food insecurity rate of 10% and higher [49]. The renewal project intends to collect food security data. To lower participant burden, researchers will be encouraged to use either the "Six-Item Short Form" [63] or the two-question option [64]. The "Six-Item Short Form" quickly assesses food insecurity among older adults [63]. A two-question subset from this short form has a sensitivity of 96% and higher and a specificity of 79% and higher [64].

Quality of Life (QOL)

We will assess QOL using one of the following tools: Satisfaction with Life Scale (SWLS) [65], food satisfaction will be measured using the Satisfaction with Food-Related Life (SWFL) scale [66], or the deJong Gieveld 6-item loneliness scale [67]. The validated SWLS is a measure of subjective well-being. It is a 5-item 7-point Likert scale questionnaire used as a measure of global cognitive judgments of satisfaction with one's life [65]. The SWFL scale is comprised of five questions on a 6-point Likert scale centered on food and meals [66]. The loneliness scale consists of six questions and assesses emotional loneliness and social loneliness [67].

Physical Activity

The validated Yale Physical Activity Survey (YPAS) estimates caloric expenditure of habitual physical activity, including exercise activities, chores, and leisure activities in older adults [68, 69.] It is valid and reliable when used with adults aged 60-86 years. Since there are no questions regarding specific exercises such as resistance training, we will ask a few additional questions regarding recent engagement in resistance training or other exercises including recent frequency, duration, and intensity.

Physical Function

Physical function will be assessed using at least one of the following tests: static handgrip strength [70-73] the Short Physical Performance Battery Protocol (SPPB) [74, 75] and a 400-meter walk test [76, 77].

Static handgrip strength is a simple, safe, reliable and valid predictor of total body strength, physical functioning, and future disability and will be done using a hand-grip dynamometer (Jaymar Hydraulic Dynamometer, J.A. Preston, Corp., Jackson, MS) [70-73]. Participants will perform the grip strength test in a seated position using their dominant arm with the elbow flexed at a 90-degree angle. They will be instructed using standardized oral encouragement to squeeze the dynamometer with as much force as possible and the highest force attained will be recorded. Three trials separated by a 1-minute rest period will be done and the highest force will be used.

The SPPB includes three balance tests, a gait speed test and a chair stand test [74, 75]. Walking speed will be measured by requesting the participant to walk at their normal pace over a 4m distance. Time in seconds to complete the full course will be recorded. Two attempts will be done, and the faster of the two times will be used. A 46-cm high straight-back chair will be used to complete the repeated chair stand test, and participants will be instructed to stand up from the chair once without using their arms for assistance. If a participant is able to complete one chair stand, he/she will be asked to stand up and sit back down five times as quickly as possible, and the time to complete one series of five chair stands will be recorded. Participants will be instructed to sustain balance in three different positions distinguished by sequential narrowing of the base of support. Position one will begin with feet together (i.e. side by side); position two will consist of the heel of one foot next to the big toe of the other foot (i.e. semi-tandem); the last position will have the heel of one foot in front of and touching the toes of the other foot (i.e. tandem). For all three positions, participants will be timed for a maximum of 10 seconds, and scores will be summed for the measure of balance for a range of 0 to 30 seconds.

Scores from 0 (inability to complete the test) to 4 (highest possible score) will be assigned to each of the three performance measures based on standard cut-points. A summary score ranging from 0 (lowest) to 12 (highest) will be calculated by adding walking speed, chair stands, and balance scores.

We will also use the 400-m walk test [76,77]. This test is a predictor of subsequent mortality in older adults. On a track (or measured corridor) each participant will be instructed to walk the track in a continuous loop as quickly as possible at a pace that can be maintained. Standardized oral encouragement will be given, as well as feedback regarding the number of laps remaining.

Measurement of Progress and Results

Outputs

- • Development of a Manual of Operations that includes all common validated tools that will be used for multistate research efforts. This manual will help ensure common research protocols are followed by all states.
- A comprehensive database of needs assessment and intervention data will be developed to allow for multistate cross-sectional data analysis and comprehensive assessment of lifestyle inventions for community-residing aging adults.
- Results from these studies will be used to provide recommendations to appropriate agencies regarding implementation of methods to improve availability and accessibility of healthful foods and physical activity for older adults.
- Continued statistical exploration of the associations among the following age-related health factors: dietary and physical activity behaviors, quality of life, socioeconomic status, race, etc.
- Molecular data of telomere length and markers of inflammation correlated with specific dietary and activity interventions.
- Using cross-sectional and longitudinal approaches, we will measure the association of dietary fat quality with changes of muscle function, mass and mitochondrial capacity. Results will be used to design intervention studies to test dietary oils (doses and types) to attend the loss of muscle mass and function in older people.

Outcomes or Projected Impacts

- Improved understanding of the nutrition and physical activity practices of community-residing adults ages 40 years and older influencing their chronic disease status.
- Reduced chronic disease incidence and/or severity as indicated through self-report, validated survey outcomes related to the targeted chronic disease and/or blood values.
- Reduced nutritional risk and improved dietary intake frequencies as measured by the DST among those participating in nutrition-focused interventions
- Increased physical activity participation among aging adults and increased physical function among those attending exercise, physical activity and/or sarcopenia interventions.

- Reduced food insecurity among those with limited incomes
- Enhanced healthspan as assessed by reduced chronic disease risk factors, increased QOL, and/or physical function.
- Study participants will gain knowledge regarding recommended nutrition and physical activity behaviors.
- Optimized healthspan through nutrition and physical activities that are cost-effective and achievable for aging or older adults.
- Study participants will implement dietary and other lifestyle goals that will attenuate muscle loss.

Milestones

1. Develop operations manual for common survey tools. o Develop SPSS-base codebooks for each of the common research tools. o Prepare manuscripts and grant submissions for studies.

2. Create lifeSPAN curriculum and prepare related grant applications. o Optimize laboratory procedures for blood collection and preparation of peripheral blood lymphocytes at multiple sites. o Prepare manuscripts and grant submissions for studies.

3. Pilot-test lifeSPAN program. o Collect survey data from across states. o Examine telomere length and markers of inflammation for selected studies. o Quantify association of dietary fat intake with mitochondrial capacity and muscle health. o Prepare manuscripts and grant submissions for studies.

4. Conduct cross-sectional data analysis using multistate dataset. o Examine telomere length and markers of inflammation for selected studies. o Prepare manuscripts and grant submissions for studies.

Projected Participation

View Appendix E: Participation

Outreach Plan

We plan to disseminate the work accomplished through this multistate project at multiple levels. We will create and distribute education materials and programs for community-level implementation, ideally through Extension but may also include Area Agencies on Aging and public health departments. Joint publications related to our research findings will be prepared and submitted to peer-reviewed journals. We will continue to do oral and poster presentations at local, regional and national professional meetings such as Experimental Biology, American College of Sports Medicine, the American Society for Nutrition annual meeting, Food and

Nutrition Conference and Expo, the Society of Nutrition Education and Behavior annual meeting, and the annual National Health Outreach Conference (Extension).

Organization/Governance

Currently an Executive Committee (chair, chair-elect, past-chair, secretary, and member-at-large) and a Regional Administrative Advisor has the administrative oversight and organization for the multistate group. All positions are elected to three-year terms by team members during the annual meeting. The term begins October 1 of each respective year. The Chair is responsible for setting the meetings, developing and posting agendas, and facilitating the meetings. The Chair also oversees the completion of the annual reports and project-related revisions. The chair-elect completes the duties in the absence of the chair. The secretary maintains the minutes and sends to the Chair to post on the multistate website. The member-at-large attends the executive committee meetings and performs other duties as assigned by the Chair. The multi-state members meet on a regular basis (every other month) via online meetings and annually face-to-fact at a date and place that is selected by the entire group.

The NE-1939 Multistate group is in the process of developing and adopting a policy and procedures manual that will guide the functioning of the group. The maximum size of the multistate group will be 25 members. Members will be expected to actively participate in, collaborate, and contribute to the multistate research and administrative activities. Members who choose not to actively participate will be asked to resign from the group. Active participation is defined as participating in at least 50% of online meetings and contributing to the collaborative research and administrative activities. Consideration for termination of group membership due to inactive status will be presented on agenda and discussed by full group membership followed by a vote by the full membership at the next group meeting (face-to-face or online). A protocol will be established for accepting new members. It is anticipated that new members will be voted upon by the current members and should have applicable expertise that strengthens the group research, at least one chapter of dissertation published, and able to obtain independent funding for participation. The best time to join the group will be during the renewal process. Candidates must submit CV and documentation of how their skills meet the group research needs to the Chair. The group will review and vote upon the respective candidates.

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2024 agInnovation Excellence in Multistate Research Award

Purpose

The fundamental mandate of the Multistate Research authority compels State Agricultural Experiment Stations (SAES) to *interdependently* collaborate in projects that two or more states share as a priority, but for which no one state could address singularly. Demonstration of interdependence is a high standard and has become a hallmark of the Multistate Research Program's management objectives.

The purpose of the agInnovation Excellence in Multistate Research Award program is to annually recognize those station scientists who are conducting exemplary multistate activities and enhance the visibility of the multistate program. A recipient Multistate Project will be selected from the pool of nominees submitted by the five regional research associations (NCRA, NERA, SAAESD, WAAESD, and ARD), and judged by the agInnovation Science and Technology Committee (STC) to exhibit sustained, meritorious, and exceptional multistate research activities.

Award

The State Agricultural Experiment Station (SAES) Directors have approved a monetary recognition of $15,000 from the Hatch Multistate Research Fund (MRF) for the winner of the Excellence in Multistate Research Award. Up to $5,000 is available to cover travel for members of the recipient project (typically the Administrative Advisor and Chair or their designees) to attend the awards ceremony at the agInnovation Annual Meeting. The remaining $10,000, and any unused travel funds, are available to support activities which enhance and contribute to the research and/or outreach objectives of that multistate project, consistent with the appropriate use of Hatch MRF. Use of these funds is a project committee decision made in conjunction with its Administrative Advisor.

Eligibility

Any current regional Multistate Project (research, ERA, CC) listed in NIMSS (www.nimss.org) is eligible for consideration for an Excellence in Multistate Research Award. **The nomination is predominantly based on the five-year project period, although outcomes and impacts over the course of the project's lifespan may be considered. A nomination that was submitted in previous years should indicate advances made since the previous submission in the transmission correspondence of the nomination packet.**

The Multistate Research authority allows other non-SAES partners to join in these project-based collaborations. Thus, many multistate projects include extension specialists as members, as well as Agricultural Research Service or Forest Service research scientists. In addition, many projects have private sector and non-land-grant participants. Moreover, the majority of multistate projects have participants from more than a single region, with many having representation from all regions such that they are national in scope.

Basis for Nomination

Each of the five regional research associations may nominate one Multistate Project chosen from the entire national portfolio of active projects. An individual project can document collaborative activities with one or more different multistate projects, if applicable, within the appropriate nomination criteria. Each regional nomination must illustrate how the project addresses at least one of the Grand Challenges outlined at http://escop.info/roadmaptext/ so that relevant success stories may be posted on the agInnovation website.

Nominations shall be made to the Chair of the respective regional Multistate Research Committee (MRC) or Multistate Activities Committee (MAC) via the regional Executive Director's office. The documentation for this type of nomination should be sufficient to allow the review committee members to evaluate the nomination according to the criteria listed below.

Criteria and Evaluation

Successful selections from regional nominations advanced to the national competition for the Excellence in Multistate Research Award will demonstrate high standards of scientific quality, research relevance to a regional or national priority, multistate collaboration on the problem's solution, and professional leadership in the conduct of the project.

All nominated projects, in the required 4-page format, shall be evaluated using the same criteria (with weights shown) based on the Project's:

- Issue, problem or situation in context of Grand Challenge(s) addressed (5%)
- Objectives (5%)
- Accomplishments predominantly based upon the past five-year project period as
    - **Outputs** (the project's products and deliverables, 10%)
    - And qualitative and quantitative descriptions of social, economic, ecological, and(or) environmental benefits related to relevant Grand Challenge(s) as:
        - **Short-term outcomes** (how has the project created awareness, 5%);
        - **Medium-term outcomes** (how has the project changed behavior, 5%);
        - **Long-term outcomes** (how has the project changed condition, 5%);
        - **Impacts** (what are the direct, indirect, and/or anticipated global benefits; how is society and the world better off, 10%)
- Added value and synergistic activities across mission areas:
    - Multi-disciplinary activities (10%)
    - Multi-functional integrated activities (10%)
    - Additional partnerships, associations, or collaborations beyond land-grant universities (e.g., private, for-profit, non-profit, government and non-government agencies;10%)
    - Emphasize what the committee did together that would not have been accomplished with individual work (10%)
- Evidence of multi-institutional and leveraged funding with examples of sources (10%)
- Summary of participating institutions and units (5%)

Selection Process

The STC will serve as the review panel. The review panel will select from the annual group of regional nominees a national winner in time for public announcement and award presentation at the agInnovation Annual Meeting each year. All nominated projects will be evaluated using the same criteria.

Award and Presentation

The national winning project will be recognized by the agInnovation Chair and USDA NIFA Administrator during the Awards Program held at the agInnovation Annual Meeting. Each regional nomination will be included in the APLU Awards Booklet "A Community of Scholars Honoring Excellence" by project number and title, technical committee chair, administrative advisor, and participating institutions. A National Awardee narrative will be created by the MRF Impact Writer and submitted to the STC Executive Vice-Chair. The title of the national winning project will be added to a plaque located at the USDA NIFA Headquarters. Additionally, the national award winner's application will be shared as an example of a successful application when next year's call for nominations is distributed.

Timeline

- November/December – Announcement sent to Directors and Administrators, Administrative Advisors and NIMSS participants by agInnovation Chair
- February 28 – Nominations due at Offices of the Executive Directors
- March – Nominations reviewed by regional Multistate Research or Multistate Activities Committees and recommendations submitted to regional associations
- March/April – Regional associations approve regional nominations at Spring meetings
- April/May - Regional associations review, edit and finalize their nomination prior to the final submission
- May 15 – Associations submit final regional nominations to STC Committee via the regional association supporting STC (**pdf or word document**)
- June –STC Committee reviews regional nominations and selects the national winner
- July – National winner announced in the agenda brief at the agInnovation Executive Committee Meeting held at Joint COPs
- July– STC Executive Vice-chair collects information from regional associations, secures project pictures, and submits materials to APLU for booklet and program script; NIFA notified for USDA NIFA Headquarters plaque inscription
- September – National winner presentation at agInnovation meeting
- November – National award announced at APLU Annual Meeting

Nomination Format

(The nomination should be a very concise summary and must be in this format.)

Nominating Region: _____

Nominator: _____ **E-mail:** _____

Project or Committee Number and Title: _____

Technical Committee Chair: _____ **E-mail:** _____

Administrative Advisor: _____ **E-mail:** _____

Project Summary (noting the following**):**

- Issue, problem or situation in context of Grand Challenge(s) addressed (5%)
- Objectives (5%)
- Accomplishments predominantly based upon the past five-year project period as
  - **Outputs** (the project's products and deliverables, 10%)
  - And qualitative and quantitative descriptions of social, economic, ecological, and(or) environmental benefits related to relevant Grand Challenge(s) as:
    - **Short-term outcomes** (how has the project created awareness, 5%);
    - **Medium-term outcomes** (how has the project changed behavior, 5%);
    - **Long-term outcomes** (how has the project changed condition, 5%);
    - **Impacts** (what are the direct, indirect, and/or anticipated global benefits; how is society and the world better off (10%)
- Added value and synergistic activities across mission areas
  - Multi-disciplinary activities (10%)
  - Multi-functional integrated activities (10%)
  - Additional partnerships, associations, or collaborations beyond land-grant universities (e.g., private, for-profit, non-profit, government and non-government agencies; 10%)
  - Emphasize what the committee did together that would not have been accomplished with individual work (10%)
- Evidence of multi-institutional and leveraged funding with examples of sources (10%)
- Participating institutions and units (5%) **(page 4 only)**

Nominations should be **no more than 3 single-spaced pages** (Times Roman 12 point and one-inch margins) plus a 1-page summary of participating institutions and units (alphabetized) for a **total of 4 pages**. Regions may utilize other information in selecting their nominee. The final regional nomination should be submitted by email to the Offices of the regional Executive Directors, by **c.o.b. February 28, 2024**:

Chris Hamilton, North Central <christina.hamilton@wisc.edu>
David Leibovitz, Northeast <david_leibovitz@uri.edu>
Cindy Morley, South <cmorley@uark.edu>
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Lisa Williamson, ARD <lmwilliamson1@ncat.edu>